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The What's New magazine

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OCTOBER
1982

PS buyer's guide: the new CORDLESS PHONES

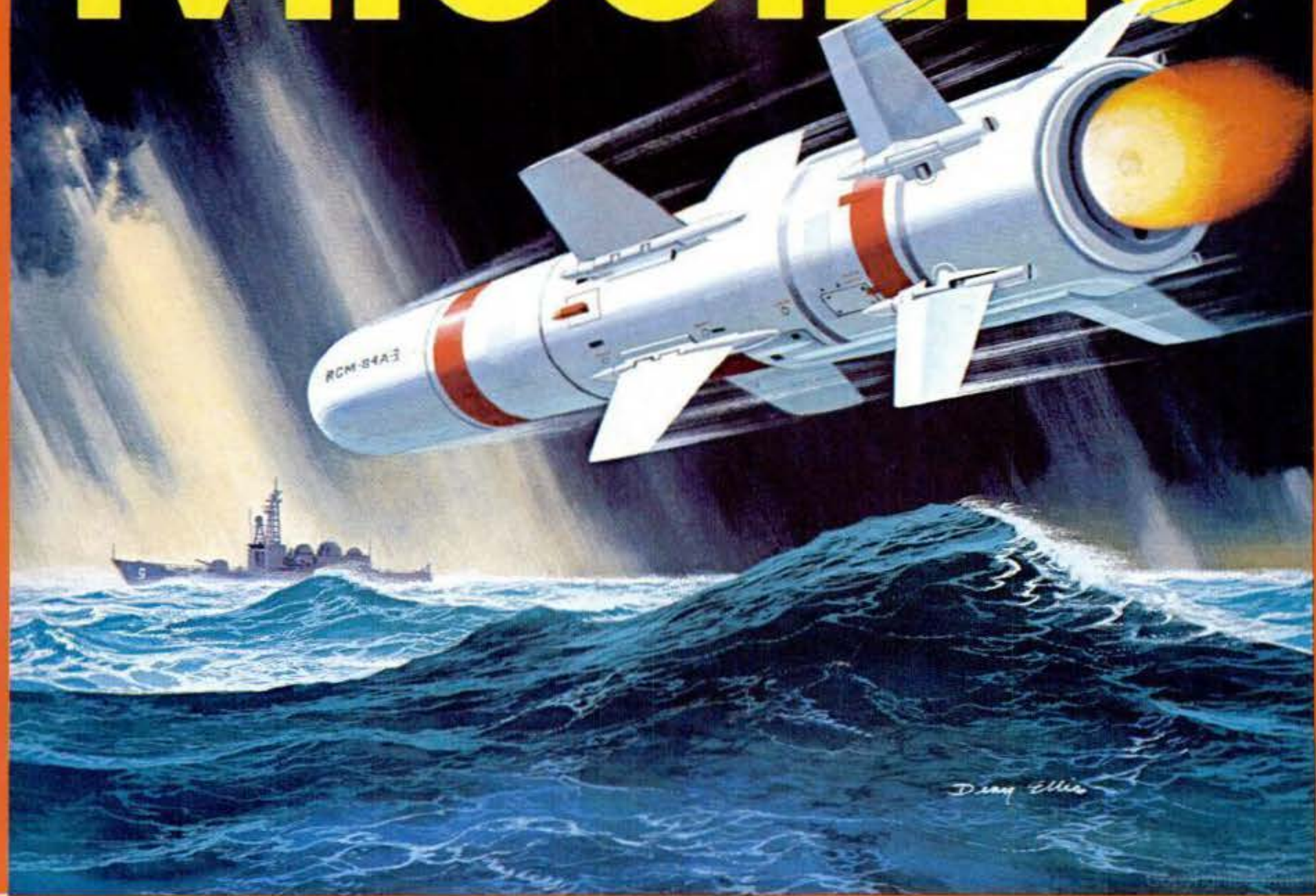
Safer skies into the 21st century: FAA'S REVOLUTIONARY CONTROL SYSTEM

THE AMAZING WINCHESTER Big-machine memory for personal computers

INSIDE THE '83's How GM, Ford, AMC, and Chrysler meet the challenge

SPECIAL HEATING SECTION:
- Catalytic wood stoves
- Kerosene heaters
- Relining a chimney

Engineering secrets of the new SMART MISSILES



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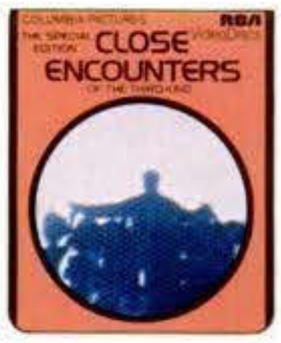
HINT #12 FROM RCA VIDEODISCS

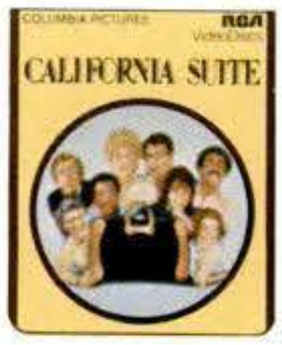
HOW TO PUT A LITTLE EXTRA MAGIC IN YOUR MARRIAGE:

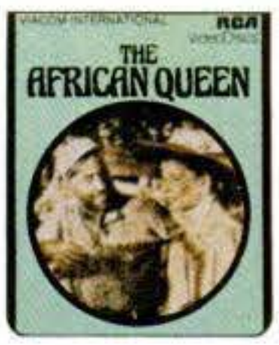
Plump up the pillows on the sofa. Forget about the office. And think about having a magical evening. The two of you. Next to each other. Alone.

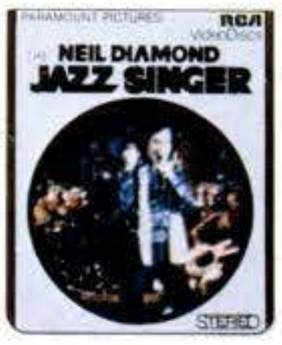
With the magic of the RCA VideoDisc System, you can get the fire burning brighter with *Some Like It Hot.* Or have a close encounter of the best kind with *Close Encounters of the Third Kind.*



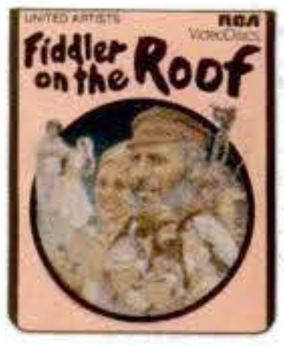
In fact, RCA VideoDiscs can keep you side by side on the love-seat for hours. Have a mini-honeymoon with *California Suite.* Get away from it all with *The African Queen.* Make beautiful music together with Neil Diamond in *The Jazz Singer.* Leap for joy over a ballet like *Giselle.*

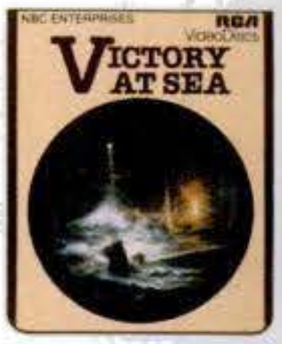






RCA VideoDiscs have over 250 fantastic programs you can bring home right now. There are movies, sports, stereo concerts, the arts—and new releases every month, so you can build your own personal collection. Players start at under $300, and VideoDiscs are as low as $14.98. The System is so easy to operate you can do it while holding hands—and RCA VideoDiscs play over and over on any brand of CED videodisc player and on any TV set. But only RCA has the variety of programs that'll put a little more spice in your life.





Watch *Fiddler on the Roof* rather than reruns on TV. Have *Victory at Sea* instead of doldrums in the den. Or show each other *Heaven Can Wait*—after the kids are in bed.

See your nearest RCA dealer now and find out just how much magic you can bring home.

And how much it can bring to your home life.

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Popular Science MONTHLY®

The What's New magazine

OCTOBER 1982
Founded in 1872/Vol. 221, No.4

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Engineering secrets of the new smart missiles
Small weapons with sophisticated seekers are revolutionizing warfare. PAGE 74

Safer skies into the 21st century: FAA's control system
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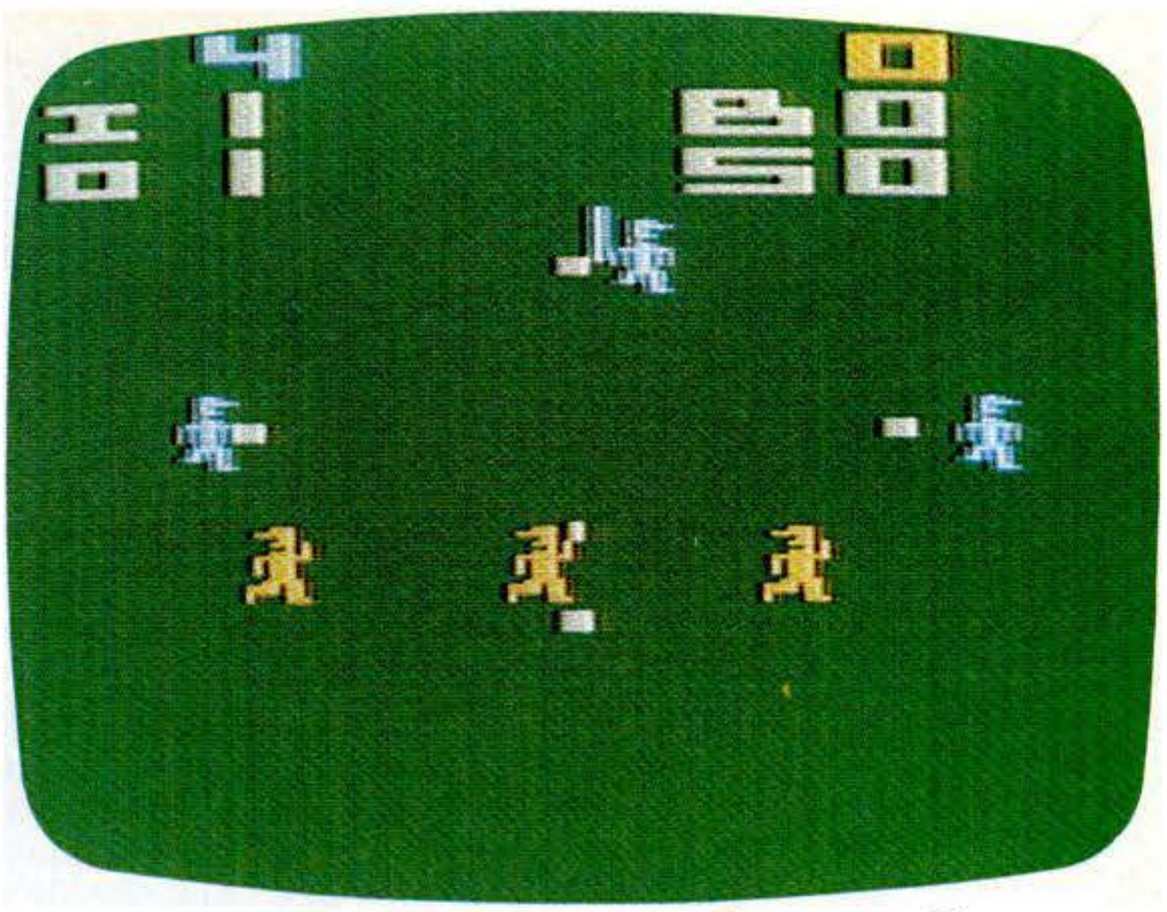

2% Preferred Atari®.

APPARENTLY, GEORGE PLIMPTON ISN'T THE ONLY ONE WHO CAN SEE THE DIFFERENCE.

Mr. Plimpton, bless him, has been quick to point out to TV viewers just how wonderful Intellivision® graphics and gameplay are.

But who better than baseball and football fans to compare Atari® sports games with ours?

As you can see from the independent research figures shown,** baseball fans were well and truly on our side.

Intellivision football provided a similar picture. With 75% of fans rooting for us. While less than 2% supported Atari.

Intellivision NFL* Football and Major League* Baseball.

As we've said all along, they're the closest thing to the real thing.

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PS READERS TALK BACK

Address letters for this column to: Readers Talk Back, Popular Science, 380 Madison Ave., New York, N.Y. 10017. Because of the large volume of mail, we are unable to acknowledge unpublished letters.

Mad, mad measurements

Metric foe Leigh B. Dennison reminds us that the U.S. and Canada became leading industrial countries using our present system of measurements [RTB, PS, Aug.]. May I remind him that we achieved that also using gas lights, Model T's, and the iron horse. If Mr. Dennison insists on using inches, foot-pounds, dozens, and teaspoons to measure his way through the world, I suggest that he at least come out from under his yardstick long enough to see the rest of us passing him by kilo-leaps and mega-bounds!

Tom Armstrong, Norwood, Mass.

If archaic and ridiculous measurements warm the cockles of Mr. Dennison's heart, why don't we resume such wonderfully useful measurements as the firkin, ell, chain, scruple, and hogshead? Why don't we require everyone to remember that there are eight drams in a U.S. fluid ounce while there are a touch over 7½ to the British fluid ounce? And let us not forget the distinctions between ounces avoirdupois, troy, and apothecary's. By all means, let us return to the pottle (half a British gallon), the grain (24 to the pennyweight), the gill (either U.S. or British), and the beloved barrel (comes in three flavors: British, U.S. dry, and U.S. liquid). Let us speak of furlongs, fortnights, and slugs—and with any luck the United States will have slipped into obscurity by the end of the decade.

Should the U.S. move to metric distress Mr. Dennison sorely, he can comfort himself with the knowledge that the English language, for all practical purposes, is the language of the entire planet. If a sensible measurement system is being forced upon us willy-nilly, our revenge is the exportation of a somewhat irrational, confusing tongue to the rest of the world.

Quentin G. Long, Los Altos, Calif.

Losing your shirt

In the gambler's ruin computation in "Calcu-letter" [PS, May], Darrell Huff provided a formula that purported to show the probability of one's capital being wiped out after a given number of wagers. With a 0.49 win probability for each bet and with 25 units of capital, it indicated an approximate 0.94 probability of losing all on or before the 60th bet. I have computed the actual probability and find it to be about 0.0017. Clearly something is missing in the application or in the employed formula.

Arthur J. Bryant, Vernon, Conn.

Mr. Bryant was among a lively group of readers who caught us exaggerating the rate of gambler's ruin. We turned to mathematics professor and PS contributor Leonard Gillman ["Solar Panels," PS, Oct. '81] to sort it out. He kindly obliged (see below) and further offered to make available at a discount to PS readers an excellent book on the subject: The Mathematics of Games and Gambling, *by Edward Packel. It is published by the Mathematical Assn. of America, of which Gillman is treasurer. For a copy, send $7.88 (that's 10 percent off) to MAA, 1529 18th St. N.W., Washington, D.C. 20036, mentioning* POPULAR SCIENCE.

The classical formula for gambler's ruin applies to the scenario in which you and an opponent bet repeatedly until one of you is cleaned out. Your goal, then, can be described as the number of bets you plan to win in excess of the number you lose—quite a different thing from Huff's "number of bets you plan to make." With this change in language, the example given is correct: Beginning with 25 units of capital against an opponent's 60 units ($50 and $120 in the case of $2 bets), and with a win probability of 0.49 for each bet, you will lose your stake about 94 percent of the time.

The article should also have pointed out that the formula does not work for fair bets: when the probability of winning any single bet is 0.5. In that case, the probability of ruin is found by dividing your opponent's capital by the total capital of you and your opponent combined.

The effect of your opponent's 51-to-49 edge (in the original example) can be further dramatized in this way: If his starting capital is 18 units or more, then his chances of winning the contest are better than yours—*no matter how much money you begin with.*

Leonard Gillman
Professor of Mathematics
University of Texas, Austin, Tex.

Huff calls a two percent edge for the house "Santa Claus odds." In fact, depending on house rules, you can reduce the edge to less than one percent by betting pass/don't pass at the craps table.

Stephen Weinreich
Monmouth Junction, N.J.

Space cadets

Over the past five years, a number of grass-roots pro-space groups have evolved to combat the budget cuts that threaten NASA. Now a new organization has arisen to give voice to the concerns of university and college students, a constituency that has the time, energy, and

Continued

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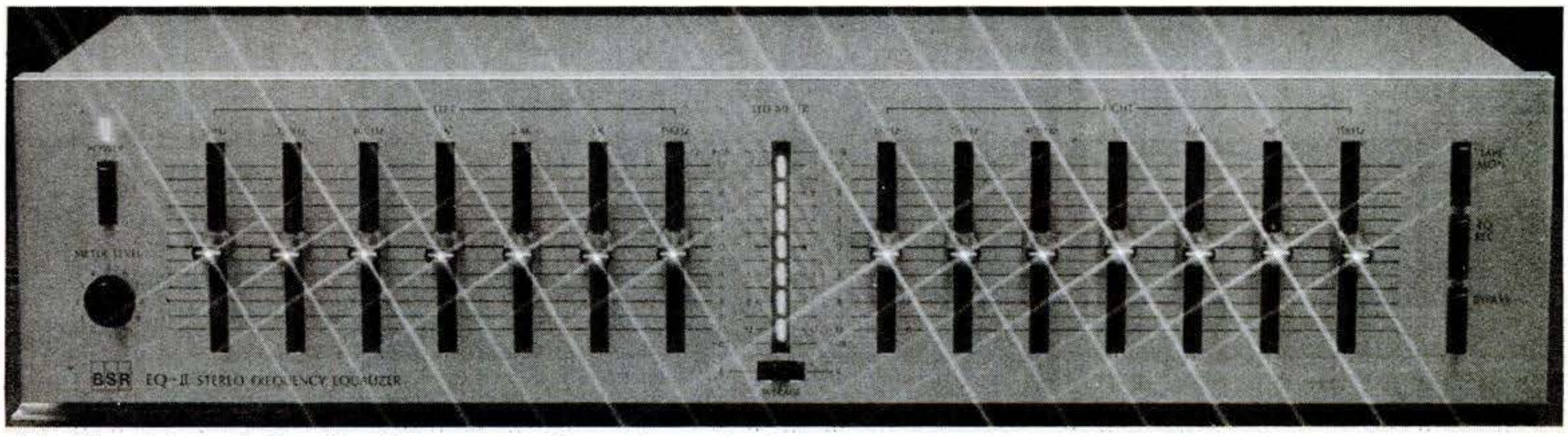
Make your stereo system's sound explode with life, improving the sound quality by 30 to 50%, with this limited $79 close-out from BSR.



It's like night and day. Crashing cymbals, the depth of a string bass, more trumpets or more voice. Now they'll all come bursting forth from your stereo system at your command.

You'll make your music so vibrant that it will virtually knock your socks off when you use this professional quality stereo Sound Detonator equalizer.

It has a frequency response from 5hz to 100,000hz ±1db. And, it's made and backed by a 2 year limited warranty by BSR, the ADC equalizer people. Our $79 close-out price is just a fraction of its true retail value.

CAN YOUR STEREO SOUND BETTER?

Incredibly better. Equalizers are very different from conventional bass and treble controls.

Bass controls turn up the entire low end as well as the low mid-range making the sound muddy and heavy. With an equalizer, you simply pick the exact frequencies you want to enhance.

You can boost the low bass at 60hz, and/or 150hz, and the mid-bass at 400 hz to animate specific areas of the musical spectrum.

And, best of all when you boost the part of the bass you like, you don't disturb the mid-range frequencies and make you favorite singer sound like he has a sore throat.

The high frequencies really determine the clarity and brilliance of your music. You can boost the high mid-range at 2400hz, or the high end at 6000hz and 15,000hz. So, you can bring crashing cymbals to life at 15,000hz while at the same time you cut tape hiss or annoying record scratches at 6000hz.

You can also boost or cut specific midrange frequency areas to add or subtract vocal, trumpets, guitars or whatever instrument ranges you prefer.

THERE'S MORE

You can push a button and transfer all the equalization power to the input of your tape deck. So, if you have a cassette deck in your car, or a personal stereo that you wear, now you can pre-equalize your cassettes as you record them with no cables to switch.

Now you can get all the dramatically enhanced sound wherever you are. This is an especially great feature for bass starved portables and high-end starved car stereos to make them come alive.

EASY HOOK UP

Use your tape monitor circuit, but don't lose it. Just plug the equalizer into the tape 'in' and 'out' jacks on your receiver. We even supply the cables.

As you listen to your records, FM stereo or 'aux', any time you push the tape monitor switch on your receiver you'll hear your music jump to life.

For your tape deck, simply plug it into the tape 'in' and 'out' jacks on the equalizer exactly as it was plugged into your receiver.

The output from your receiver is always fed direct to your tape deck for recording and with the touch of a button, you can choose to send equalized or nonequalized signal to your recorder.

When you want to listen to your tape deck, just press tape monitor on the equalizer and your tape deck will work **exactly** as it did before. Except, that now you can choose to listen to it with or without enhancing equalization.

You won't be listening to any distortion or hum. The Sound Detonator has a 95db signal to noise ratio and total harmonic distortion of only 0.018%.

Once you've set your equalizer controls, switch it in and out of the system. Then you'll hear such an explosive improvement in sound you'll think you've just added thousands of dollars of new speakers and equipment.

No one would believe that a $159 component let alone one at our $79 close-out price could do so much.

WHY A CLOSE-OUT

BSR is a very large company. Somebody decided to market equalizers under both their ADC subsidiary and the BSR names. Well, we never thought it was a very practical idea. And, now they seem to agree.

From now on you'll only see ADC equalizers. But, because they didn't know what to do with these that were labeled BSR, we got them for a song.

So, you can go to any HiFi store and buy an ADC equalizer made by the parent company BSR, or you can get this super BSR equalizer while our limited supply lasts for only $79.

Oh yes, if you want to know more about BSR, they also own DBX, the noise reduction company and if you're familiar with the X10 remote control system for your home, that's BSR too.

THE FINAL FACTS

There are 14 slide controls each with a bright LED to clearly show its position. Each control will add or subtract up to 12db. (That's a 24db range!)

There are separate sound detonation slide controls for each channel at 60hz, 150hz, 400hz, 1000hz, 2400hz, 6000hz, and 15,000hz.

There's an LED VU meter to show the relative channel output levels of the left, right and average of both. Plus there's a meter level control. It's 16-9/16" wide, 7-1/2" deep, and 3-9/16" tall.

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Wake up the sound in your stereo. Your sound will explode with life as you detonate each frequency band with new musical life.

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PS readers talk back

[Continued]

enthusiasm to make an impact on the political process. In two years, Students for the Exploration and Development of Space (SEDS) has grown rapidly from two chapters to 121, including five outside the U.S. This enthusiasm stems largely from the realization that the lack of aggressive space goals and the steady deterioration of existing programs endanger our future and demand an organized response from the world's campuses. Interested students should write to us for information on forming a chapter at their college or university.

Peter H. Diamandis, Chairman
SEDS International
372 Memorial Dr., Cambridge, Mass.

The editors strongly support these space goals. For a complete analysis of national space policy, see "It's Time to Stop the Space Retreat," this issue.

Piezo possibilities

Since reading about piezoceramic devices in the July issue, I keep imagining possible applications: gas turbine engines with no blades to pit or corrode; windmills that use all the energy in the wind, including gusts and gales; silent submarines with fishtails instead of propellers. But my favorite idea is an outboard motor for a canoe: A battery under the seat would set a fishtail swishing behind the canoe as I glide silently through the reeds. Let's hope this is not one of those ideas that we read about once and then never hear of again.

Gene Marquis, Winnipeg, Man.

On military machinery

Your Army Turbine Winded item in "Detroit Report" [PS, July] offers up more misinformation in a brief paragraph than most M1-tank critics manage in an entire page.

The Army selected the turbine engine for its new main battle tank because of its inherent high power output, small size, reliability, durability, and its potential for growth as the state of turbine technology advances. As with any new technology, the engine experienced some problems during development and the transition into production. This was not unexpected and the problems were not abnormally high in either frequency or seriousness. They did, however, generate enough concern within Congress that the Army was directed to initiate development of a "backup" engine. Contrary to your report, the "backup" diesel is not a proved engine, nor is it the same type used in the M60 tank. It is the AVCR 1360 development engine, whose power output is comparable to the turbine but whose state-of-the-art design involves technical risk comparable to that ascribed to the turbine three years ago.

Meanwhile, since a modification to the air-filtration system of the turbine engine, 435 M1 tanks have accumulated nearly 200,000 miles of operation under a wide spectrum of environmental conditions without a single engine failure attributed to dust ingestion. I know of no study that concludes that the M1 tank has a combat life of only 43 miles, as reported. The current assessment of mission reliability is 351 mean miles between failures, a statistical value based on an extensive test program. With continuing field operation, application of component modifications, and measures to improve production quality control, this figure steadily increases.

Duard D. Ball, Major General, U.S. Army
Program Manager, Abrams Tank System
Warren, Mich.

Two points in your excellent article on the High Mobility Multipurpose Wheeled Vehicle ["HMMWV," PS, June] require elaboration. First, the HMMWV program is a tri-service effort. The vehicle is being developed to meet the needs of the Army, Marine Corps, and Air Force. The tri-service approach provides lower costs to the taxpayer by eliminating duplication of effort and by reducing unit life-cycle cost through volume purchasing and common logistics support. Second, not all M151 jeeps in the inventory will be replaced with the more expensive HMMWV. Many of the jeeps will be replaced by the utility version of the Commercial Utility Cargo Vehicle (CUCV), much like a Chevy Blazer or AMC Cherokee. The HMMWV will be used only in the specific battlefield roles for which its increased mobility and special capabilities are required to enhance operational effectiveness and the probability of survival.

Frank J. Colson, Chief
Vehicle Requirements and Resources
Vehicle and Equipment Div.
Dept. of the Air Force, Washington, D.C.

Oxygen and energy

Barry Morgan's letter [RTB, PS, July] disputing my earlier contention [RTB, May] that burning fossil fuel depletes atmospheric oxygen contains a glaring error in logic. He says that Earth's oxygen supply could not have come from photosynthesis because the oxygen produced by a growing plant is identical in amount to that later consumed by the plant when it decays. *This is true only if the plant does indeed decay.*

In fact, in the distant past tremendous amounts of vegetation lived, produced oxygen, then did not decay but instead became coal. The oxygen thus remaining in our atmosphere represents the amount that would have been consumed if the vegetation had decayed. It also represents the amount that will disappear if we ever succeed in digging up and burning all undecayed fossil fuels.

Howard J. Hansen
Federal Way, Wash.

The seat-belt debate

I would like to suggest a compromise between Dana Synder and Burke Brush [RTB, PS, May] on the subject of seat belts.

Continued

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IN 70 SECONDS, TURN YOUR FAVORITE SLIDES INTO FABULOUS PRINTS.

Now you can make professional quality color prints from your slides, instantly. Without messy chemicals, bulky equipment, or a week of waiting. Now, when friends or relatives ask for a copy of a much admired slide, you can make it right before their eyes.

You probably agree 35mm color slide film is an ideal format. It's cheaper to buy and process, it makes great wall-sized slide shows, and the slides store easily. And there are no negatives to lose. The drawback has always been the time consumed in getting prints made—it takes a week, it's inconvenient, and costs a dollar per print or more.

Make large, vivid color prints from slides like this in just 70 seconds.

Vivitar's® amazing invention.

But now Vivitar has developed an inexpensive, easy-to-use instant slide printer™ that you can use at home. There's no skill required. Just insert your slide, push a button, and seventy seconds later you have a magnificent color print. It's that simple.

What's more amazing is the quality of reproduction. Unlike other instant printers which sell for $300 or more, the far-less-expensive Vivitar makes prints that are as good or better than the local photo finisher. The quality is superb. The colors are rich and pure. And because it uses the new style Polaroid® 669 film, the prints are just like ordinary printing paper (and don't need any coating).

At the heart of this sophisticated printer is a precision enlarging lens from the same engineers who created the highly respected Vivitar Zoom camera lenses. Exposure is automatically set, or can be manually adjusted to improve a slide that's too dark or too light. The printer is 10" high, 6" wide, 4" deep, and is beautifully designed in black high-impact plastic with blue trim. It weighs only 3 pounds. One year limited warranty.

Color prints measure 3¼ × 4¼", with an image size of 2⅞ × 3¾". The color Polaroid film is priced from $7.50 to $8.50 for a pack of 8 prints, depending upon store discounting. Now you can shoot color slide film for its economical costs and advantages. Then make selected color prints for as low as 93¢ each, saving hundreds of dollars. As a system, it's far less expensive than using color print film—and has all the flexibility that slides give. Plus, your Vivitar printer and film can be tax-deductible if you use slides or prints in your professional occupation.

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By ordering now, you'll receive a *free roll* of Polaroid film, good for eight beautiful prints. You'll even receive a *free set* of four Duracell® "C" batteries. So you can make eight prints of your own, on us. Be as critical as you wish of the result. You must be satisfied. If not, simply return the Vivitar slide printer within 30 days, for a prompt, courteous refund. And keep the eight prints for your trouble.

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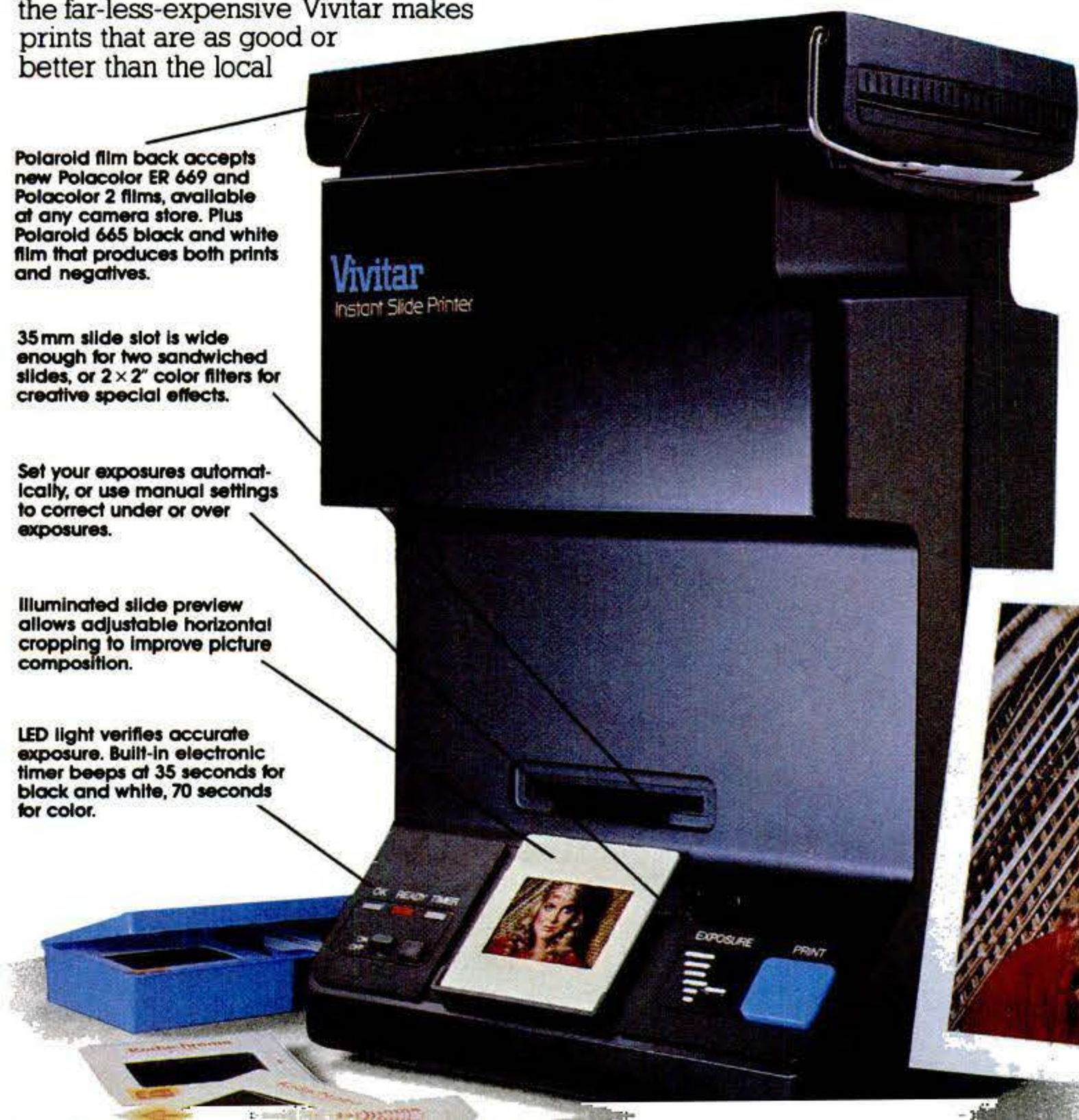


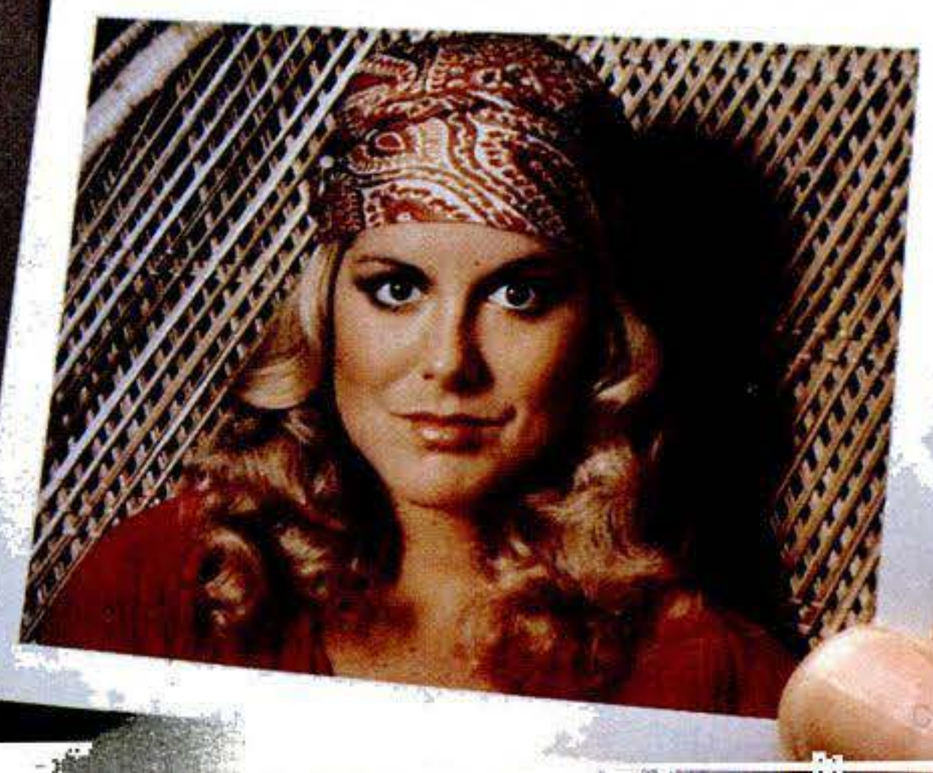
Polaroid film back accepts new Polacolor ER 669 and Polacolor 2 films, available at any camera store. Plus Polaroid 665 black and white film that produces both prints and negatives.

35mm slide slot is wide enough for two sandwiched slides, or 2 × 2" color filters for creative special effects.

Set your exposures automatically, or use manual settings to correct under or over exposures.

Illuminated slide preview allows adjustable horizontal cropping to improve picture composition.

LED light verifies accurate exposure. Built-in electronic timer beeps at 35 seconds for black and white, 70 seconds for color.



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ULTRA LIGHTS: 4 mg. "tar", 0.4 mg. nicotine, LIGHTS: 11 mg. "tar", 0.9 mg. nicotine, KING: 15 mg. "tar", 1.1 mg. nicotine, av. per cigarette, FTC Report DEC. '81.

Winston
America's Best.

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[*Continued*]

Brush's beef should not be with Snyder's legitimate desire to retain a semblance of decision making; it should be with the insurance companies, which charge all people equally regardless of whether or not they use seat belts. If seat belts have been proved to save lives to the satisfaction of the insurance companies, why not reduce rates for seat-belt users—or, to accomplish the same thing another way, raise the rates for nonusers? If this were done, people would feel satisfaction that they were reducing their insurance cost (as well as risk) by using seat belts, rather than resenting nonusers for increasing everybody's rates.

Fritz Handel, Iskut Lake, B.C.

Fuel feud

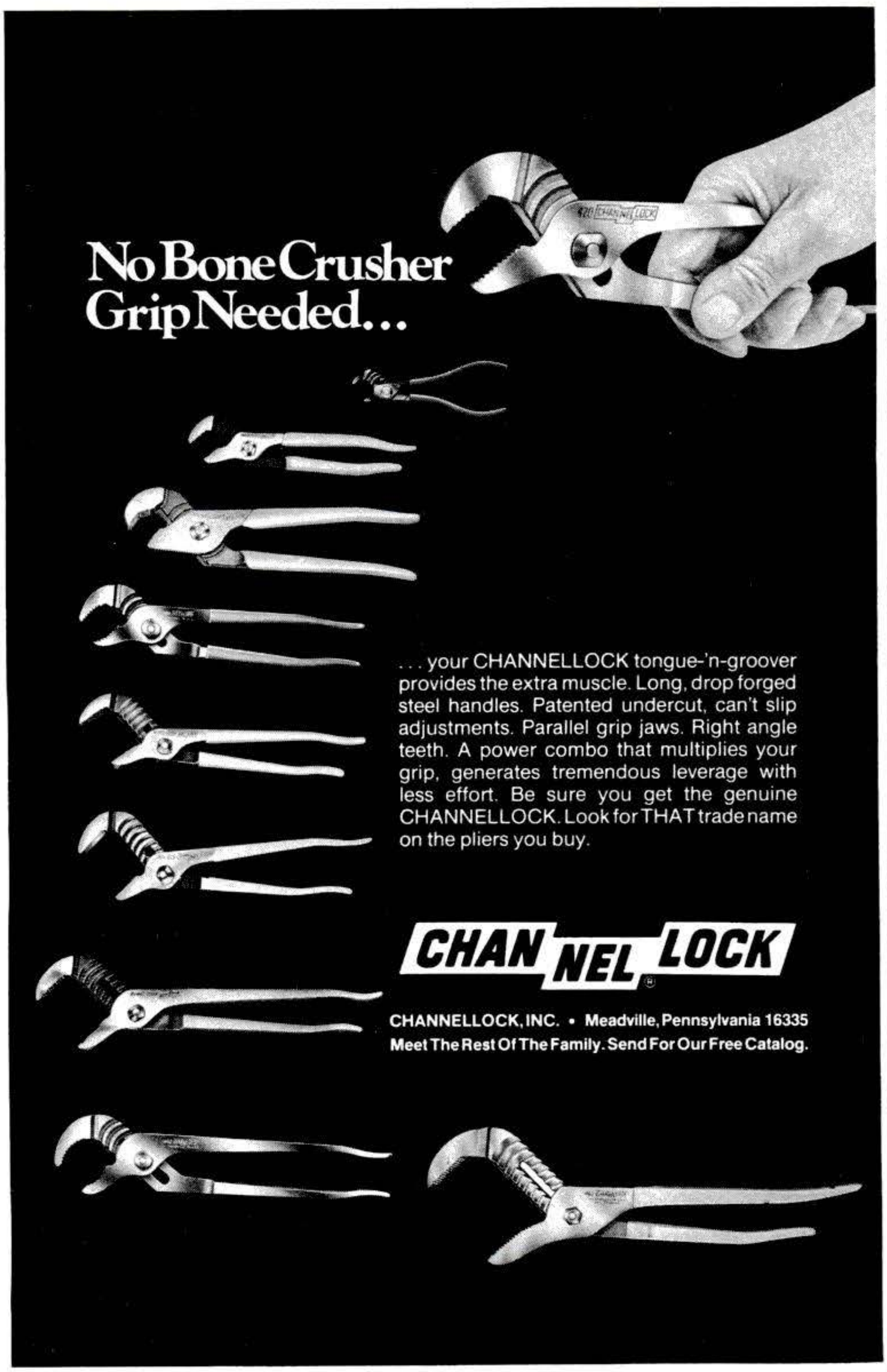
Evan Powell did not do his homework properly for his discussion of comparative heating costs ["Housepower Clinic," PS, June]. Natural gas has never had units that recorded 80 percent efficiency. The new condensing-type units (which are in their infant stage) do approach that plateau, but the figure most commonly used by heating engineers in the residential field is 75 percent. Regardless of the area of the country, steady-state gas efficiency will probably be 70 to 75 percent.

The oil-efficiency numbers for older burners is 75 percent on average. Units installed after 1965 record efficiencies of 80 percent. With the modern flame-retention oil burners, efficiencies obtained by testing laboratories around the country are 85 to as high as 88 percent.

Edward Besch Jr., Technical Director
Oil Heat Institute of Washington
Seattle, Wash.

Evan Powell replies: "The efficiency figures cited were based on my own tests of existing furnaces, and they reflect 'real world' conditions (oil-burner performance degrades without annual maintenance). Homeowners can compute their heating costs more exactly, however, by using the Department of Energy's Annual Fuel Utilization Efficiency (AFUE) rating.

"According to the AFUE tests, the top-rated oil and gas furnaces and boilers achieve about the same efficiency percentages—in the mid to high 80's (excepting pulse-combustion gas units [PS, Sept.], which rate up to 96 percent efficient). If you look at averages, however, it is true that oil appliances make a better showing. The reason, says DOE staff engineer John Talbott, is that all oil-burning units have powered burners (seldom less than 70 percent efficient) while some gas appliances have atmospheric burners (which can be as low as 55 percent efficient). Since the latter are the cheapest models, they are naturally attractive to many builders. Thus, large numbers are sold and the average efficiency for gas systems drops accordingly. This is something of a red herring, though, because consumers who are concerned about overall costs probably would not choose one of these bottom-end units."



Hauling lumber

The little imported pickups have been a great boon in these days of soaring gasoline prices. However, inflation hasn't affected the size of plywood or studs. Plywood still comes in four-by-eight-foot sheets, and studs are still eight feet long. Why can't we have beds on these small workhorses that accommodate standard building materials with the tailgate up?

Clifford R. Dempster
Fort Wainwright, Alaska

Corrections: Contrary to a statement in "Feedback-Carburetor Systems" [PS, Sept.], the Ford EEC III system *can* be tested without the $1,500 electronic tester—using a vacuum pump and gauges. See Ford's "1980 Car Service Highlights" (No. 0320-121) for details.

Burkhart Grob of America, maker of the G-109 "Motor Glider" featured in the August issue, has moved to 1070 Navajo Dr., Bluffton, Ohio 45817. PS

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You'll love the way we hated it until an amazing thing happened.

Love/Hate Thermostat

You're probably expecting our typical sales pitch, but get ready for a shock. For instead of trying to tell you what a great product the Magic Stat thermostat is, we're going to tear it apart. Unmercifully.

When we first saw the Magic Stat, we took one look at the name and went "Yuck!" We took one look at the plastic case and said "How cheap looking." And when we looked for the digital readout, it had none. So before the salesman even showed us how it worked, we were totally turned off.

REAL LOSER

So there it was—at first blush a real loser. But wait, we did find one good feature—a feature that led us to a discovery. The Magic Stat installs in a few minutes and no serviceman is required. Thermostat wires in your wall follow standard color codes. So when you install a Magic Stat, you attach the red wire to the red location and the white to the white. That's playschool stuff. And it's safe. Conventional thermostats installed over the past 20 years are generally only 24 volts, so you can either turn off the power or work with the "live" wires without fear.

OK, LET'S TEST IT

The Magic Stat installation was so easy that the least we could do was test it. And that's when we made an incredible discovery. We discovered that the Magic Stat was probably the most consumer-oriented, technologically-advanced and most sophisticated thermostat ever developed on the face of this earth and in our galaxy for all times ever. What made us switch from hating the thing to loving it? Read the following.

The Magic Stat has six setback settings per day and a seven day program. That means that you could set it for 70 degrees when you get up in the morning, drop the temperature to 54 degrees when you go to work, raise it to 68 degrees when you return for dinner, raise it up to 72 degrees after dinner as you watch TV and then drop it down to 62 degrees when you go to sleep. Count them—five settings with one to spare.

In one day the Magic Stat is programmed for the whole week and for the weeks to come. If you want a different schedule for Saturday and Sunday, you can individually adjust the thermostat for those days, too. "Big deal," you might think. "What's so incredible about that?" Read on.

You set most electronic setback thermostats to the time you want the furnace to go on in the morning, so when you wake up, your room is once again warm. But what if one morning it's bitter cold outside and the next morning it's much warmer? This means, that setting your furnace to go on at the same time may, on one morning, leave you cold and on the next morning cause you to waste energy by warming up your house too soon.

By golly, the Magic Stat has everybody beat on this one too. Throughout the night it senses and computes the drop in temperature and the time it will take to get your room to your exact wake up temperature. So if you want to wake up at 7 AM to 70 degrees—that's the temperature you'll wake up to every time. Because it's a patented concept, no other thermostat has this feature. But wait. There is also a patent on the setting feature.

SIMPLE TO SET

To set the thermostat, you press just one button. A small LED light scans the temperature scale until you reach your desired temperature and then you release the button. You change the temperature naturally, throughout the day, up to six times. The unit responds and remembers that exact living pattern. The present temperature is displayed by a glowing red LED on the temperature scale.

The system also computes the ideal length the furnace should stay on to keep the temperature within a range of plus or minus one and one-half degrees. A battery backup lets you keep your stored program in its memory so power outages as long as eight hours won't let your unit forget. And if something happens and your power is out for a few days, the unit will automatically maintain 68 degrees when the power is restored.

WE WERE READY

Quite frankly, we were so impressed with the unit, its ease of installation and setting plus its many energy-saving features, we seriously considered advertising it until we realized that our customers would probably not want to trust their future comfort to a product called, Magic Stat. What if something went wrong with the unit? How substantial was this Magic Stat outfit? Remember a thermostat is something you live with as long as you live in your home, and they're supposed to last ages.

Well, we did our homework. We found the company to be a sound, well-financed organization. They have been in business for several years, and they back their products with a three-year limited warranty. In addition, the company has a policy of buying back your unit in one year if you haven't saved its full cost in energy savings. We were satisfied with the company, the people, the product, its incredible features, the company's commitment to the product and above all, the real energy savings possible.

We are so impressed now with the Magic Stat that we're going to make buying one irrestible. Buy one from us for only $79.95. Install it yourself in a few minutes or hire a handyman to install it.

Then enjoy the savings this next winter. Not only will you save up to 30% on your heating bills, but you're eligible for the 15% energy tax credit. Then if you're not absolutely in love with this product one year later, return it to JS&A. You'll get all your money back and you can reinstall your old thermostat.

But we're counting on a few things. First, you will realize an energy savings and a comfort that will far surpass what you are currently experiencing. Secondly, you probably will sleep better breathing cooler, more moisture-laden air yet wake up to just the right temperature. And with the manufacturer's year-long savings guarantee, you can return your unit with no penalty and reinstall your old thermostat if the Magic Stat doesn't pay for itself during the very first year of use.

Beauty is not skin deep and a name doesn't really mean that much. But we sure wish those guys at Magic Stat would have named their unit something more impressive. Maybe something like Tinkle Temp.

To order, send a check or money order to the address below or credit card buyers call toll-free 800 228-5000. Use order number (shown after price). Add $3.50 for postage and handling. (Ill. res. add 6% sales tax.)
Magic Stat **$79.95** (0040PS01)

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THROUGH THE VIEWFINDER

By EVERETT H. ORTNER

Two-zone autofocus

Just another autofocus camera? Not the Canon Snappy 50. In fact, it just barely qualifies as autofocus. Using Canon's infrared range-finding system to determine whether the subject is near or far, it focuses the lens on one of two points: 5.8 feet for close-up shots, 13 feet for shots from intermediate distances to infinity. The f/3.5 35-mm lens—actually moderate wide angle—has sufficient depth of field to deliver reasonably sharp pictures.

The automatic two-zone feature offers one way for camera makers to hold the line on price yet deliver an instrument of good quality. Among other automatic features: wind and rewind; exposure via a programmed shutter-diaphragm that delivers speeds of 1/20 to 1/500 second and apertures from f/3.5 to f/16; and a flash adjustment that will compensate for different ranges.

List price of the Snappy 50 is $145. If you're a reader of discount ads, you may wonder why you should pay $145 for a camera with limited autofocus ability when you can get another Canon product, the well-proved Canon Sure-Shot, with complete autofocus and a better lens, for about $100. The answer, of course, is that list prices are a fiction in many areas and among many photographic dealers.

In the case of the Sure-Shot, the list price of $240 contrasts with the real-world discount price of $100. I can't guess what the real-world price of the Snappy 50 will be.

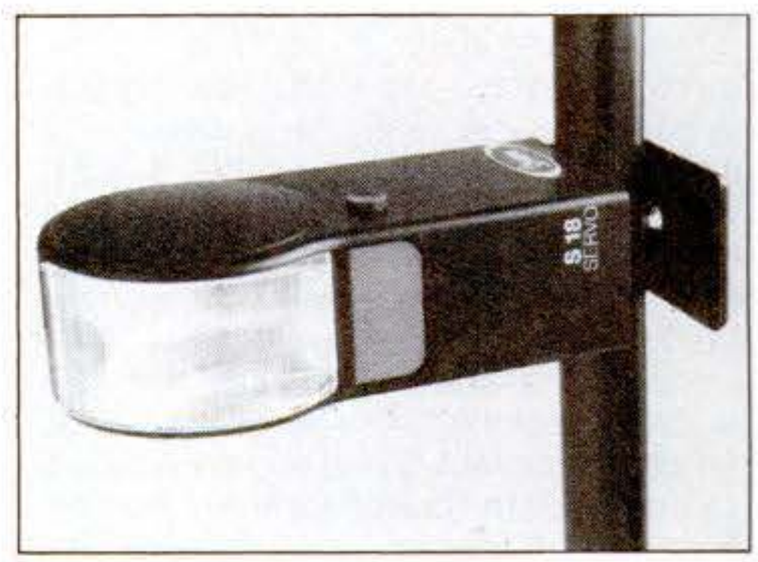
There's also a Snappy 20, which differs from the 50 in having a fixed-focus, four-element lens (no need for autofocus) with a maximum aperture of f/4.5—slightly slower than the Snappy 50's f/3.5 lens. It differs, too, in coming in five different colors: red, yellow, blue, white, and black. (The Snappy 50 comes only in black.) List price: $115.

Tripod system

"Any tripod situation that might arise in the field" can be handled by the Cullmann Touring Set, claims its U.S. distributor, Vivitar Corp. That's a big claim for a camera-support system whose central component, the tripod, stands only 32 inches high when fully opened. In other respects, however, the Touring Set offers as ingenious and diverse a group of holding devices as I've ever seen. First, there's the tripod proper, which telescopes to gadget-bag portability and, made of fiber-filled ABS plastic, weighs only 19 ounces. Then there's the clamp. Its angled ridged jaws can grip such things as fences, tree branches (up to three inches in diameter), pipes, and steering wheels. The long ground spike is designed for dirt, sand, or gravel. The wood screw is handy for securing a camera to a fence post or tree stump. And finally, there's the suction pad, which provides a surprisingly firm grip on such smooth, hard surfaces as glass, painted metal, and plastic. The list price of the German-made Touring Set is $119.95.

Clamp-on slave

Need an extra fill light to remove unwanted shadows when you're taking a portrait, or to highlight your subject's hair, or to brighten a background? Slave flash units, which are triggered by light from the master flash—the one on or near your camera—are designed to do exactly that. The Spira-Slave S-18 solves the problem of mounting with its own built-in ratchet clamp. It has a guide number of 30 (with ASA 25 film). The unit costs $29.95 (two for $52.95) from Spiratone, Inc., 135-06 Northern Blvd., Flushing, N.Y. 11354.



ISO AKA ASA

Should we say farewell to ASA in the name of international concord? ASA, as you know, stands for American Standards Assn., the former name of what is now the American National Standards Institute (ANSI), and is used to designate the speed of a film under particular standards. It is the same as BSI (British Standards Institute) and JSA (Japan Standards Assn.), is approximately equal to Russian GOST speeds, and is related to the German DIN (Deutsche Industrie Norm) speeds. Instead of printing that whole alphabet on one tiny film box, wouldn't it make sense to use one designation like ISO—for International Standards Organization? Yes—and increasingly the photo industry is using ISO instead of ASA. Latest to do so is Kodak, and when you see ISO instead of ASA on those little yellow boxes, you'll know why.

High-tech hybrid

As predicted in POPULAR SCIENCE last December ["Now They're Designing the Next Generation of Superlenses"], plastic-and-glass hybrids are on the way. First of the revolutionary products will be Vivitar's 450-mm mirror lens, designed by Ellis Betensky and made by Bauer, a German firm, in Taiwan. On-sale date will be about January. PS

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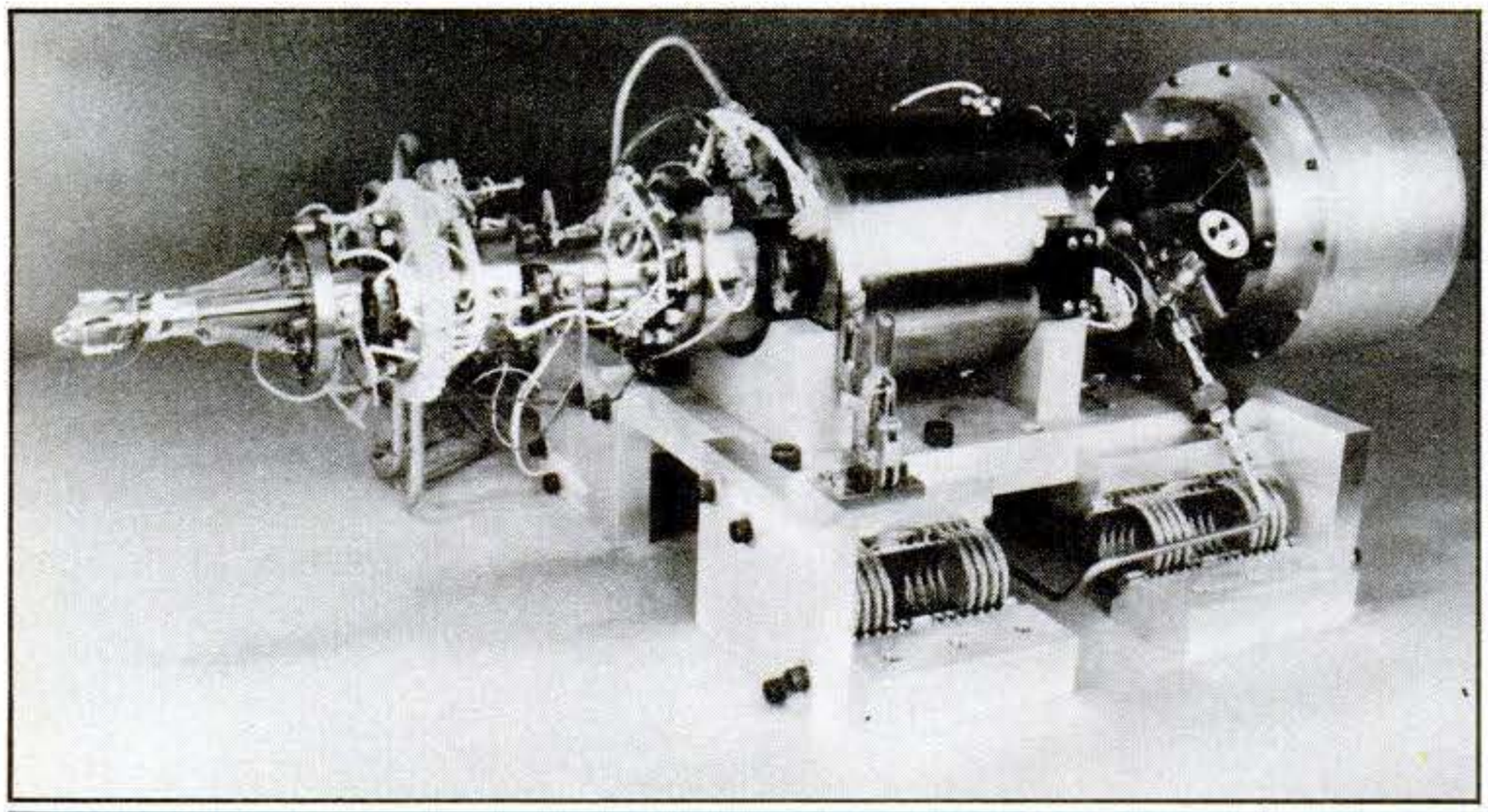
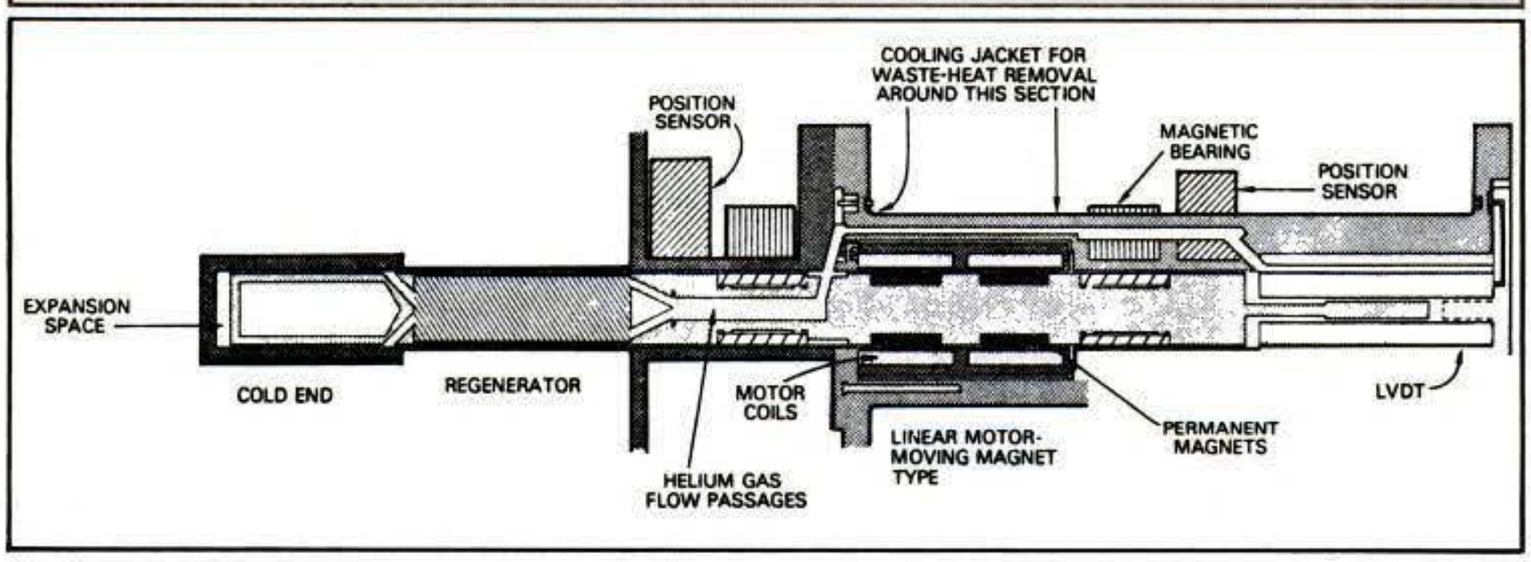
SAFETY IS A SNAP

SCIENCE NEWSFRONT

By ARTHUR FISHER





Friction-free fridge

Problem: Design a closed-loop cryogenic refrigerator for use in spacecraft—one that will perpetually recirculate a gas for long periods without leakage, be virtually maintenance-free, and avoid the breakdowns of bearing seals and lubricants.

Drawing on advanced technology from a variety of fields, engineers at North American Philips Corporation have produced an elegant solution, seen in the photo above. It eliminates the problems of friction and mechanical wear by drastic approaches: The refrigerator's parts are magnetically levitated and centered so that they never touch the sides of their housing. This was accomplished by substituting electronically controlled linear magnetic bearings for ordinary sliding or ball bearings. And the chance of mechanical failure was reduced by eliminating mechanical linkages and a drive shaft and replacing them with direct-drive linear motors to drive the piston and displacer of the Stirling-cycle cooler. The Stirling cycle was chosen because of its high thermodynamic efficiency. It could not be used in space previously because of mechanical problems that limited life span to less than the needed five-year capability of the new design.

The cooler consists of three major sections, including a cold side, a displacer/regenerator, and an adjoining displacer-motor housing. One linear motor expands helium gas in the refrigerator to absorb heat; a second one compresses the gas and rejects it. (The expansion section is shown in the drawing.)

The new refrigerator has been successfully operated by engineers at NASA's Goddard Space Flight Center and at North American Philips Corp. laboratories. It generates five watts of cooling power at 65 degrees Kelvin when its compression heat is dissipated at 300 degrees Kelvin, and it can maintain that output comfortably for five years or more.

The first model of the cryogenic cooler should fly aboard a NASA space satellite. There, infrared detection equipment, of the type used to make extraterrestrial atmospheric or heat-sensing observations, will be cooled down to cryogenic temperatures. But its designers say that there is obvious potential for making earth-resource observations, and in surveillance for law enforcement. And the combination of technologies used in the cooler makes its principles adaptable to other, earthbound uses. Maintenance-free operation, for example, would be especially valuable in remote installations such as polar weather stations. And because potentially contaminating lubricants are totally eliminated, the ideas embodied in the cooler might be grafted onto equipment for food processing and textile manufacturing.

Radio astronomy in space

The prototype antenna being tested aboard the space shuttle in the artist's concept below would be used in a radio-astronomy system called Very Long Baseline Interferometry—VLBI, for short. The method relies on using super-accurate atomic clocks to synchronize observations made by radio-telescope antennas separated by great distances. One such pair, in California and Australia, is 6,600 miles apart. The longer the distance, or "baseline," between antennas, the larger the effective telescope diameter and the higher the resolution of the images that are produced.

"In years past," says physicist Dr. Samuel Morgan, of NASA's Marshall Space

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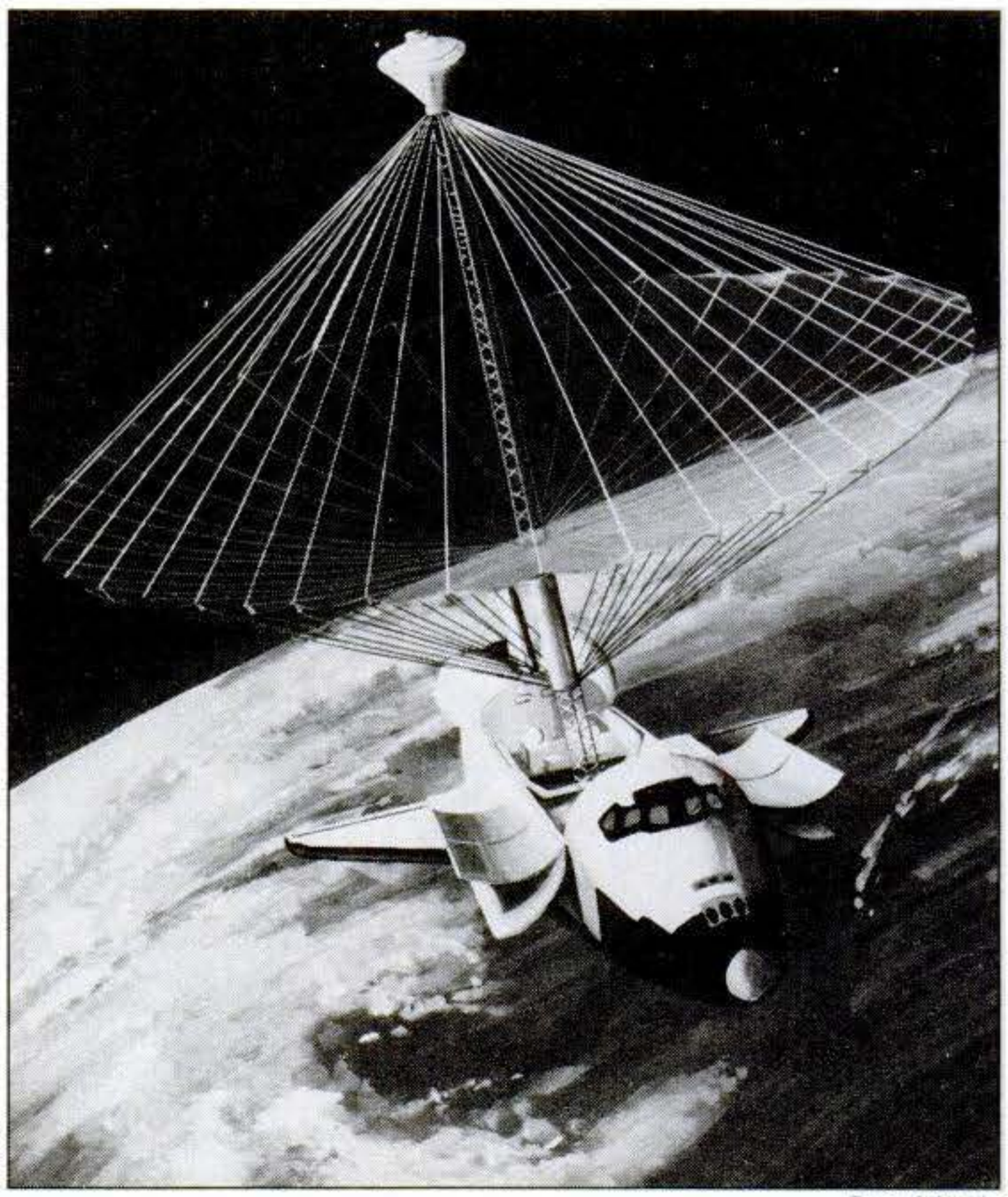

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You'll be proud. This is no ordinary 'cheap' watch like you'd expect to see advertised for $19.95.

For openers, it has a real **stainless steel** easy-flex adjustable band. And, it's powered by an 18 month Japanese battery. You'll find the type of precision quality and features you'd expect from a $50 luxury timepiece.

Wait till you see just how good this beautifully crafted dual time, 24 hour alarm, 24 hour chronograph stop watch looks on your wrist.

Wait till you feel how light and comfortable it is to wear. And, speaking of comfort, at only $5, it's really comfortable on your pocketbook too. But, don't forget there's a catch.

A COMPLETE SYSTEM

You can time and evaluate your jogging progress or time your next airline flight. It's easy to time long distance calls too with this super accurate 24 hour 1/10th second chronograph stop watch. Plus, there's a lap timer and you can start and stop this stop watch without having to reset it to zero.

If you put a soda bottle in the freezer to get it cold, it won't explode if you've set your alarm for 30 minutes. You won't miss important meetings, forget to take pills or wake up late because of a power failure when you use this repetitive 24 hour alarm as your personal alarm clock.

If you travel or frequently make long distance phone calls to another time zone, it's easy to keep track of the other time with the 2nd time zone feature.

You'll never be at a loss for the day of the week or the date. And, the advanced quartz crystal circuitry in this timepiece is incredibly accurate.

LOADED

You'll receive your watch in a beautiful transparent plastic display gift box. As you remove the watch you'll really notice the highlights from its brushed stainless steel band.

And, it's not a cheap one piece band. This easy-flex band opens at the clasp and is fully adjustable in size. You'll also get a back light for easy night viewing, and an AM/PM indicator plus indicators for all its other functions.

The quality Japanese battery should last up to 18 months and is easily user changeable. Plus, this watch is backed by Innovative Time's one year limited warranty for your protection.

THE CATCH

Frankly we are losing our shirts on the alarm chronograph, but we're looking for audiophiles who use audio cassettes.

If you buy top name TDK and Maxell cassettes, you probably pay $3.50 to $4.50 each for a 90 minute cassette.

We want you to try DAK's new Gold Label MLX ultra high energy, normal bias cassettes. Not at $4.50 or even at $3.50 each, but at a factory direct price of just $2.49 for a 90 minute cassette.

We challenge you to compare the frequency response, dynamic range and signal to noise ratio of our new Gold Label MLX to Maxell UDXL or TDK SA. If they win, we'll not only give you back your money, we'll give you a free gift for your trouble. And, DAK's come with a deluxe hard plastic box, index insert card and a limited 1 year warranty.

WHY, YOU MAY BE ASKING?

You're very valuable to us in the form of future business. Over 150,000 customers have responded to bonuses like this. We find most of you keep buying once you've tried our cassettes and our prices; and that's a gamble worth taking.

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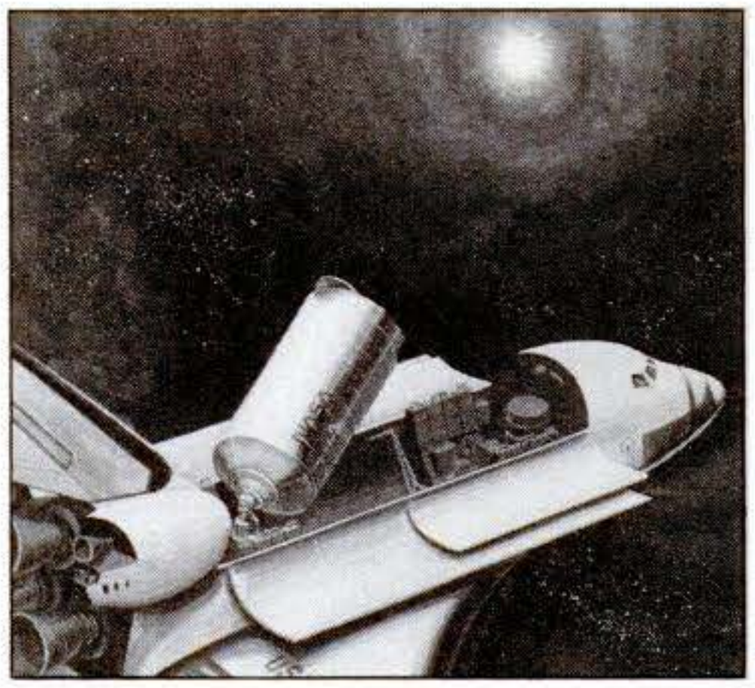
Center, "ground-based radio telescopes have produced some spectacular results, including the discovery of pulsars, quasars, and other galactic phenomena. But now we're looking to space-based systems for even better results . . . Imagine the resolution you would get if you were to link up with an antenna far out in space."

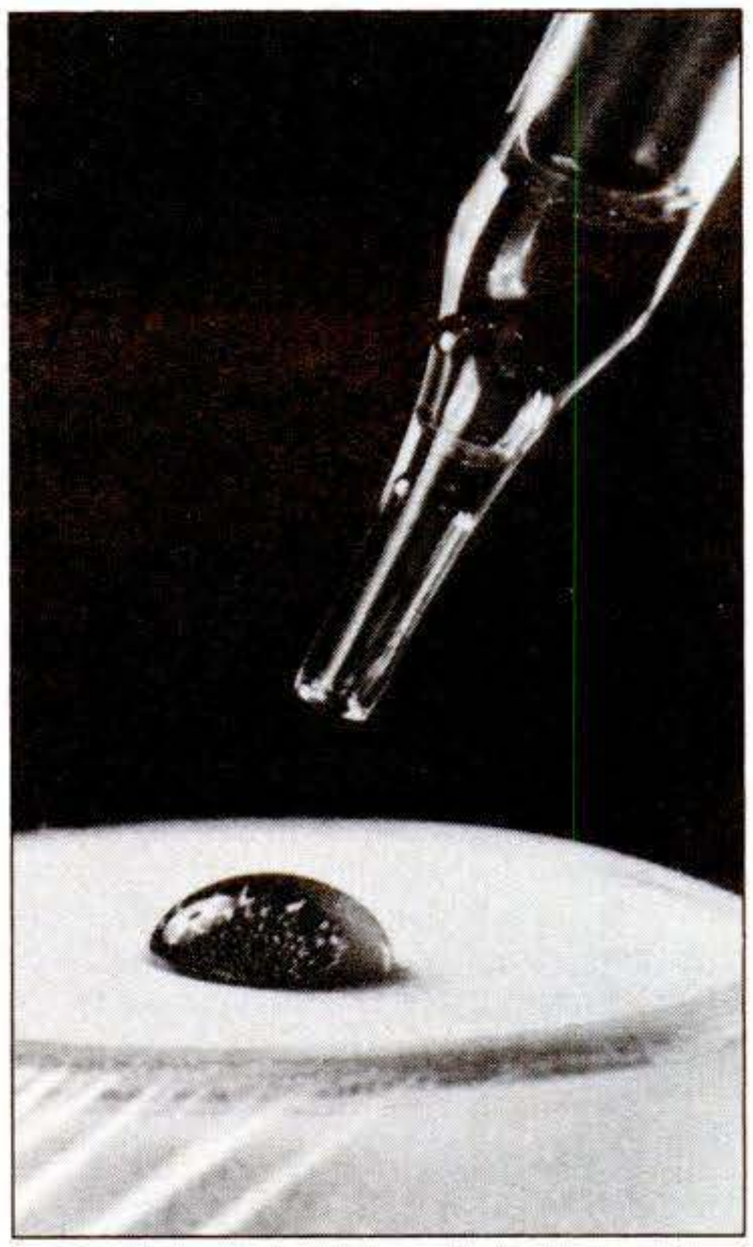
Dr. Morgan is a member of NASA's Very Long Baseline Interferometry Working Group. One of the group's proposals is to place a large antenna (like the one shown) in a 5,000-km (3,107 mile) orbit around Earth sometime in the late 1990's. Coupled with an antenna on Earth, the system would give a resolution greater than a milli-arc-second—roughly the angle of view someone in Los Angeles would have of a dime in New York.

"Ultimately," says Morgan, "we'd like to place an interferometer about 200,000 kilometers out, which would give us a radio-astronomy capability that far exceeds what we have today. An interferometer placed that far from Earth may be possible by the turn of the century."



Skin-like dressing

A new medical dressing to replace conventional gauze-and-tape bandages in certain applications has been introduced by 3M's Medical Products Division. The



new dressing, seen above, is called Tegaderm. It is transparent and lets in air and water vapor, but is impermeable to liquids, as you can see in the photo. It is designed to cover cuts, pressure sores, and skin-graft sites, among other things, and can be left in place longer than conventional bandages without causing skin irritation because of its breathability. It also lets medical personnel inspect covered wounds without having to remove the dressing. For the time being, Tegaderm bandages are available only to health-care professionals.

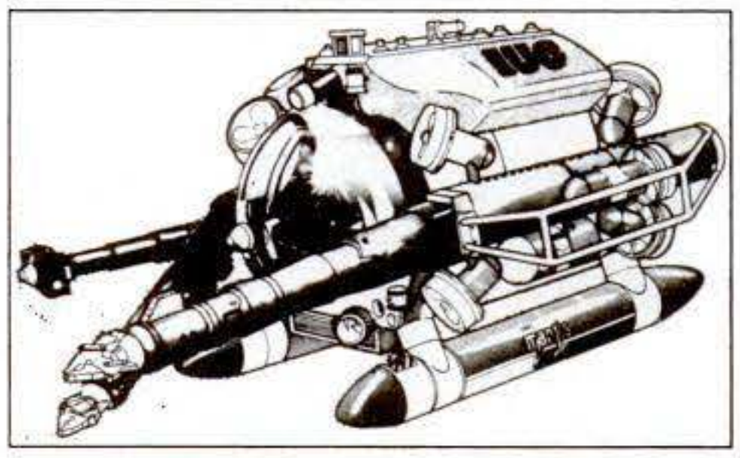
Orbiting sun scope

Scheduled to fly aboard a space shuttle Spacelab in the late 1980's, the Solar Optical Telescope (photo above) should help clarify a number of mysteries about the sun's behavior. Perkin-Elmer Corporation has been selected by NASA to prepare the preliminary design. Cost for the entire effort has been estimated at $57 million.

The 52-inch-diameter telescope would fly a 14-day mission each year for 10 years, orbiting the Earth at an altitude of 250 miles. Solar physicists hope the data gained by the orbiting observatory will help explain the origin and evolution of the sun's magnetic field, the origin of solar flares, and the nature of the sun's inner workings.

Hybrid submersible

The Mantis Duplus, shown below, is a new hybrid tethered submersible that can be either one-manned or remote-controlled. Built by Osel Ltd. of Great Britain for IUC International, Inc., it is designed for undersea oil and gas operations at depths up to 2,300 feet. It will work in one of three modes: with a pilot in control of all procedures, including mechanical ma-



nipulation and "flight"; with a more passive pilot on board merely as an observer, all other work being handled by an operator on the surface; and as a completely remote-controlled underwater vehicle. Its thrusters can hold the craft steady in a three-knot current. Should it become entangled, its tether can be cut; there are 100 hours of life support available. PS

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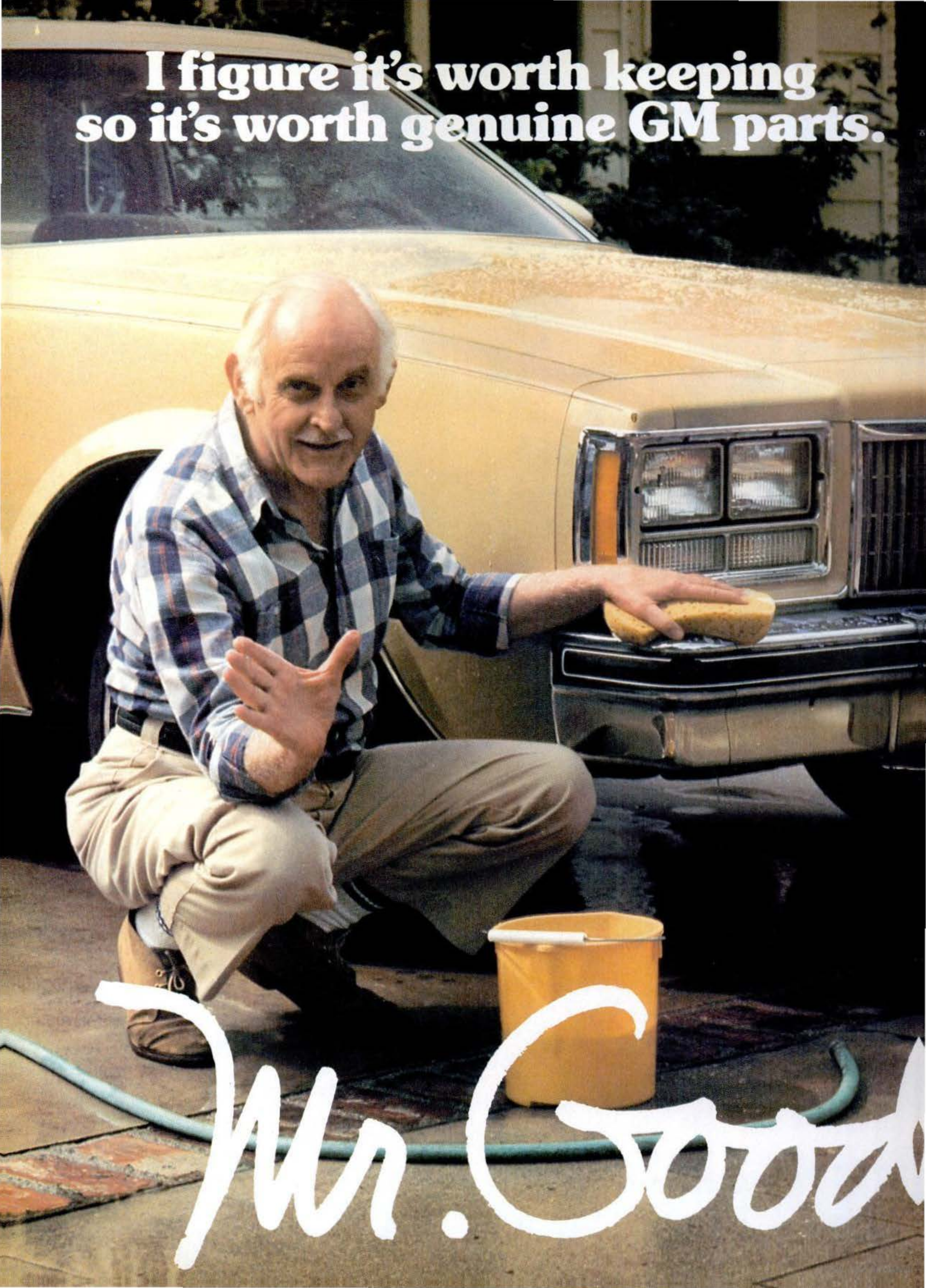
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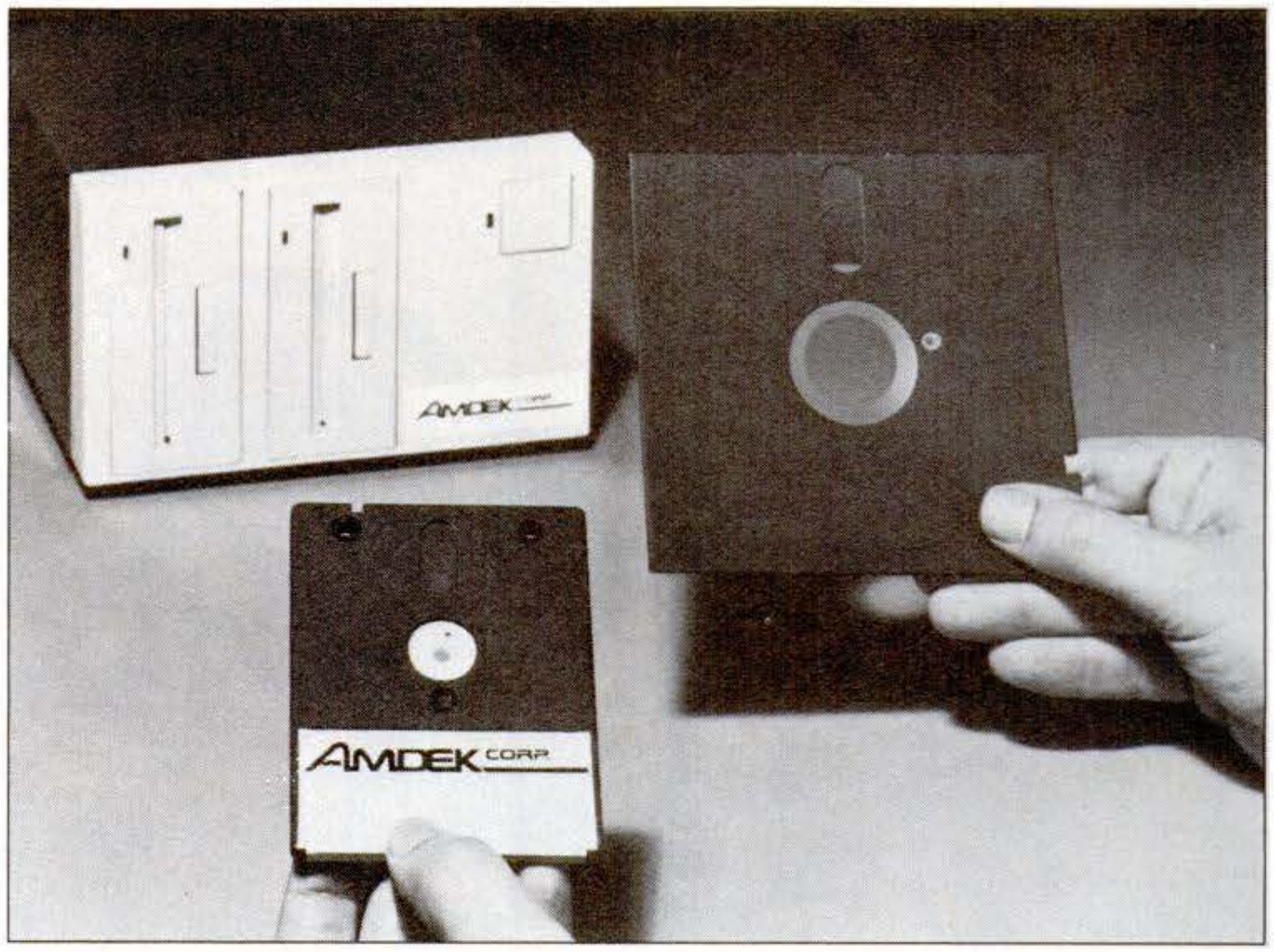
BITS & BYTES

By JOHN FREE



Shrinking mini-floppies

HOUSTON, TEX.

Nestled among cabinet-size mini-computers, clattering printers, and glowing CRT's at the National Computer Conference held here recently was a new peripheral component: a drive system for shirt-pocket-size micro-floppy discs, shrunken versions of the 5¼-inch mini-floppy magnetic discs (right, in photo above) often used with microcomputers. I spotted the micro-floppies at booths of several major Japanese firms. The tiny new discs add to a growing variety of incompatible disc sizes and types for computer mass-storage systems.

One micro-floppy version, Sony's 3.5-inch disc, has gained quick U.S. acceptance. Hewlett-Packard has agreed to buy $30 million worth of Sony drives for future products. The 3.5-inch discs spin at 600 rpm—twice the speed of mini-discs. Single-density discs store up to 438K (kilobytes) of nonformatted information. By contrast, conventional 5¼-inch mini-floppies store about 75K, and eight-inch floppies, about 240K (formatted).

Also, there are other tiny discs. Late last year three Japanese firms, Matsushita, Hitachi, and Hitachi Maxell, established standards for a three-inch "compact" floppy disc. The Japanese standard is plug compatible (i.e., it works with standard interface circuits) with standard 5¼-inch drives: Rotation speed (300 rpm), data-transfer rate, and recording capacity per track match mini-floppy systems. Amdek Corp. (Arlington Heights, Ill.) has shown a preliminary design (photo) for a three-inch micro-floppy, too. Like the Japanese hardware, Amdek's discs are protected by a hard plastic cartridge. A lid flips open when you insert the cartridge. The drive is also plug compatible with 5¼-inch units, and the twin-drive system can put up to 820K on two discs.

Other U.S. firms are devising micro-floppy systems, too—ones that may be incompatible with Japanese machines.

Quick looks

- A great range of data bases—stored information on businesses, demographics, economics, stocks, etc.—is now available to VisiCalc users on their personal computers. VisiCalc software is an "electronic spread sheet" that permits mathematical interaction between rows and columns of data displayed on a CRT. It's marketed by VisiCorp (San Jose, Calif.), which has teamed up with Data Resources Inc. (Lexington, Mass.) to make DRI's statistics available on a data-used basis. Businesses routinely use such data bases with larger computers but pay big fees just for access.
- Epson (Torrance, Calif.) attracted crowds to its National Computer Conference booth with the book-size HX-20 microcomputer. The computer has a full-size keyboard, liquid-crystal screen (20 by

Continued

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Is Lower Back Pain Making You An On-Again, Off-Again Cripple?

by Eugene Griffin

Read how one man freed himself from this crippling pain.

It happened aboard a Lufthansa flight to Frankfurt, Germany where I was going for a business meeting. The plane hit an air pocket and suddenly my back "went out."

If you've ever suffered from lower back pain, you know what this can mean. In my case, the stewardess *had to lead me off the plane* when we landed. "This is the first time this has happened?" she asked. When I told her no, she said:

"Oh, then you should have a Prosana Belt." She then told me she had lower back trouble, too, and without the Prosana Belt, she didn't think she could hold her job. "It practically saved my life!" she went on.

I'll be sure to get one, I told her. But what I was really thinking was how could a belt that helped her—a woman about 110 pounds—help a slightly overweight guy of six feet like me? Besides, I thought, I've tried practically everything short of an operation. So I went to my hotel room, took a hot bath, several aspirin and laid down for the night hoping for the best.

Couldn't get out of bed

The next morning the pain was worse than I could ever remember. *I had to roll out of bed onto my knees and crawl to a doorknob to get to my feet.* Again, I took a hot bath and some aspirin, but again, it didn't do much good. If I had been back home, I would have called and canceled the meeting. But here I was in Germany and scheduled for a meeting with five other businessmen *I* had set up. So there was nothing I could do but go through with it.

Lunch Included, Too!

The pain must have been apparent the moment I walked into the room because the first man I met smiled sympathetically and said, "You look like your back is bothering you." It is, I answered. "Haven't you heard of the Prosana Belt? he asked. I nodded yes. "And you don't *have* one?" he persisted. No, I said, continuing around the room, anxious only to get the meeting over with and go back home.

After the meeting, the man who asked me about the Prosana Belt suggested I join him for lunch. Since he was the key man on the deal, I accepted. But instead of driving me to the restaurant, he took me first to a surgical supply store where he bought me a Prosana Belt. I had no other choice but to put it on right there, though all I could think of after thanking him was to say, Is that it?

"That's it," he replied. "Now let us take a little walk to a nearby restaurant I know you'll enjoy."

The Most Amazing Walk Of My Life

If I had known the "little walk" was going to take almost a half hour, I never would have gone—business deal or no. But that was all part of his plan! Because by the time we reached the restaurant, *my pain was gone!* I even reached down and touched my shoelaces just to see if I wasn't imagining things. I can't believe it, I said. It's like a miracle. "Yes, I know," he answered, "I said the same thing when I first wore the Prosana Belt. Occasionally," he added, "I still say it, although any troublesome condition or pain that persists should be brought to the attention of your doctor."

Tested & Proved In Hospitals

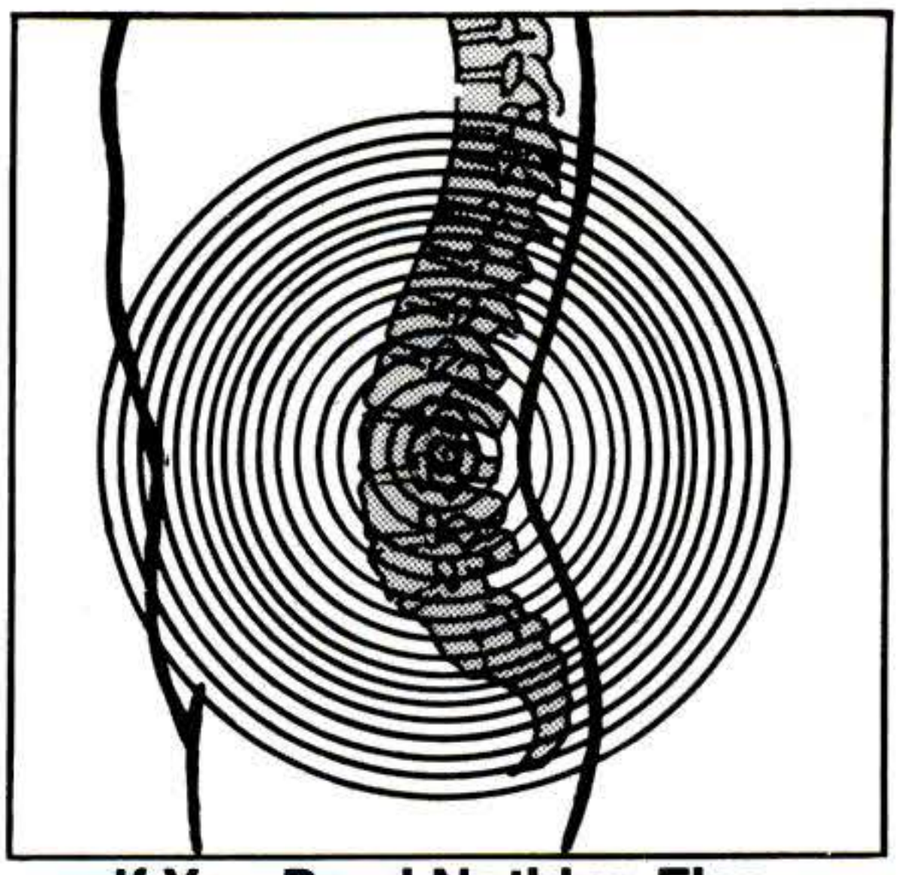
Over lunch my friend proceeded to tell me about the Prosana Belt. How it was invented by a doctor, tested and proved in hospitals and clinics; even on people so crippled with lower back pain, they had to wear steel braces! How it was, and is, used throughout Europe by tennis champions, Olympic bobsled medalists, soccer players—by all kinds of people who are constantly putting incredible strains and stresses on their backs. In fact, he concluded, its effectiveness has been so proven, *its purchase is included under Germany's national health coverage plan.*

Save $14.00! Special Free Trial Offer!

When I returned home, I told all my friends with bad backs about this marvelous belt. But when they tried to buy one, they found no one in the United States had even heard of it! So, I called my friend in Germany (incidentally, I got that order) and told him I'd like to import some Prosana Belts. He told me the cost of one *in Germany* was $44.00 in American money. Since I would have shipping costs, taxes, handling and so forth, I decided to see if I could make a special bulk importing deal with the manufacturer. And, I'm happy to add, I was able to. Yes, you can now try the Prosana Belt for only $29.95—$14.00 less than what you would pay in Germany. What's more...

You Can Prove Its Effectiveness To Yourself Risk-Free For 30 Days!

If you suffer lower back pain like me, you've probably tried every "cure" there is and so you're probably skeptical. Which is why I'm making this iron-clad, no-risk guarantee: If you're not convinced that the Prosana Belt relieves your lower back pain fast...that it works where other methods and devices have failed...that it lets you bend over, garden, do household chores, even play sports *pain-free*, I'll return your money *in full.*



If You Read Nothing Else Read This Doctor's Report:

"I've turned from my initial skepticism, indeed rejection of the Prosana belt, to an eager proponent of it. I now have checked more than 40 cases from my practice and after studying a file with more than 100 statements, I have no doubts about the effectiveness of the belt." Dr. Ludwig Hecht

HERE'S WHAT USERS SAY:

"I have been suffering from lower back pain for years. Nothing helped, not even a steel corset. After wearing the belt, I am freed from the pain and it has never come back." Mr. H. Kilian, Olympic Medalist & 3-Time World Bobsled Champion

"I suffered from severe back pain caused by tennis, and since I did not want to take any medication, I have begun to wear your belt. It is hard to believe how quickly I have got rid of my back pain." Mr. D. Sturdza, Swiss Tennis Champion

"Often I could tolerate the pain only with strong medication. The Prosana Belt has freed me from taking pills." Mrs. F. Polenz, Housewife

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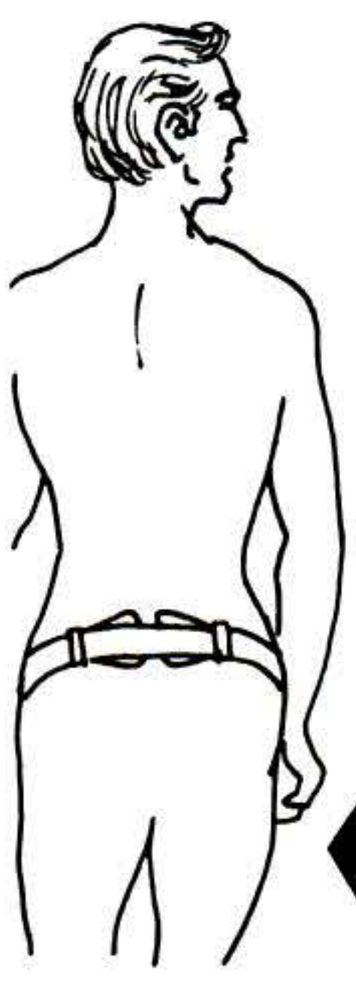

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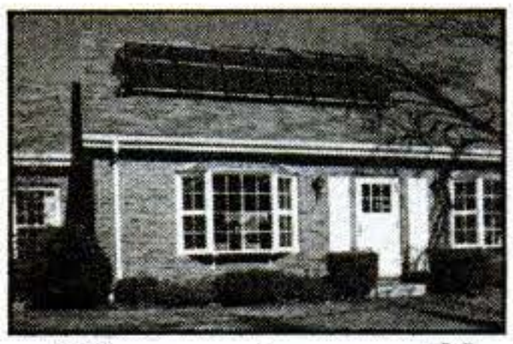

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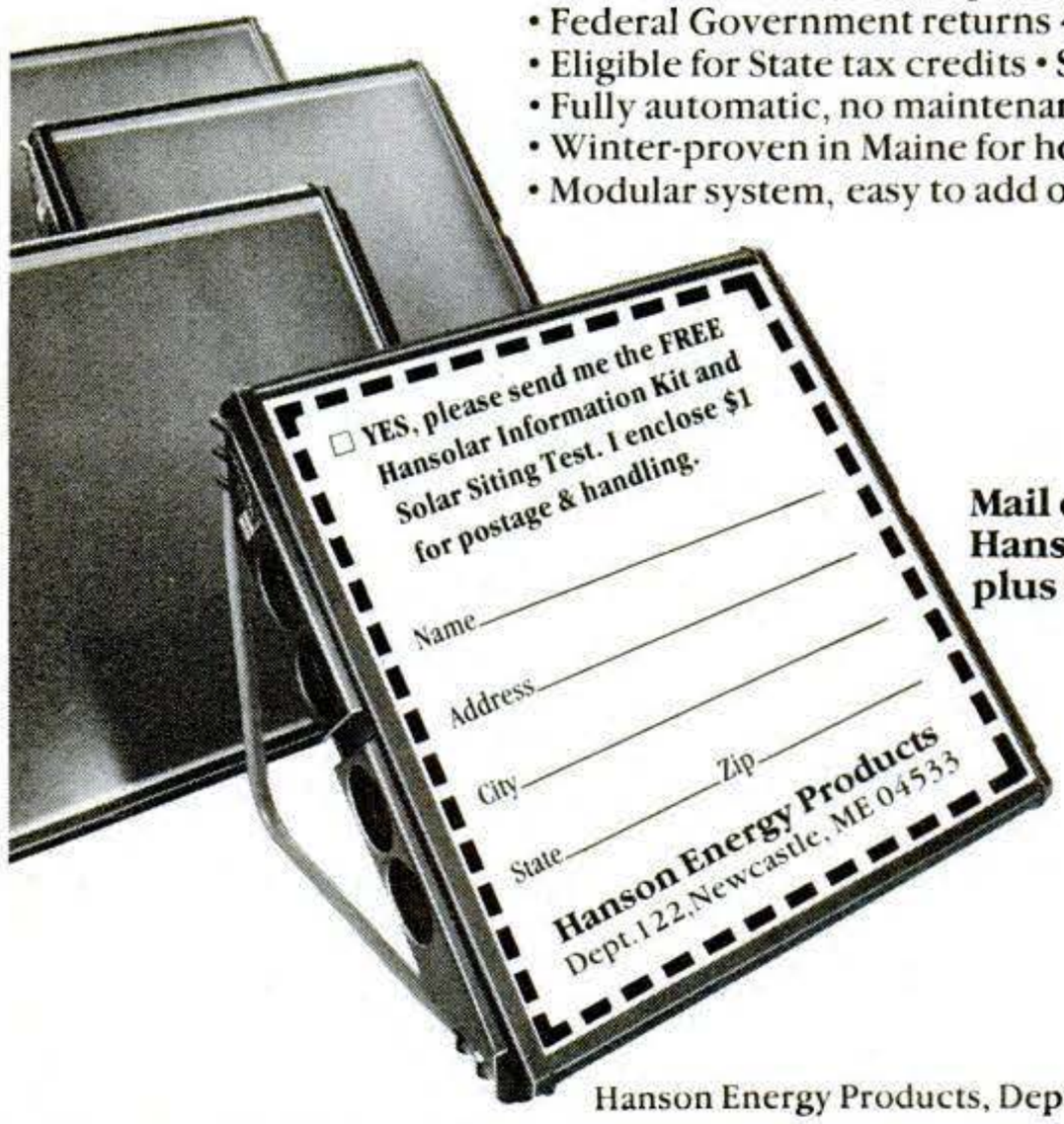

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Bits & bytes

[*Continued*]

four characters), and 24-column dot-matrix impact printer. There's space for an optional microcassette drive. The $795 HX-20 comes with 16K of RAM (random access memory) and 32K ROM (read only memory). Rechargeable batteries keep it running up to 50 hours.

- A combination computer/game machine/music synthesizer was shown in Houston by Commodore Business Machines (Wayne, Pa.). Its $180 MAX Machine accepts a BASIC cartridge, and a new display chip provides 16-color graphics and a 40-column-by-24-line TV display. Commodore's new Model 64 computer resembles the budget VIC 20 computers, but the $594 model 64 has 64K of memory and can run CP/M software with an add-on Z80 microprocessor board.
- Old meets new in Zenith Data Systems (Glenview, Ill.) Z100 series of desktop computers. They feature both eight- and 16-bit microprocessors, plus five slots for plug-in S100-bus boards. The S100 bus, introduced in the early 1970's, now has a great range of accessory boards for microcomputers. Single-housing Z100's also have 128K of RAM, two 320K 5¼-in. drives, and high-resolution color graphics.
- Magnetic-bubble memories, the solid-state storage devices that can replace disc drives, are used in a 10-pound, book-size computer from Teleram Communications Corporation (White Plains, N.Y.). Unlike the bubble-memory Compass computer with a flat video screen [B&B, PS, Aug.], Teleram's portables have a four-line, 80-character liquid-crystal pan-

el. A full-size keyboard is provided. Bubble-memory models of 128K or 256K are $2,795 and $3,495. There's 64K RAM for the low-power Z80 microprocessor.

- Radio Shack's new TRS-80 PT-210 (photo) is similar in size to Teleram's computer, but the 210 is a portable data terminal with a thermal printer that puts up to 80 characters on 8.5-inch-wide paper. A 110/300-baud acoustic telephone coupler is built in. The 15-lb. portable terminal costs $995. Radio Shack has also introduced a new zero-to-300 or 1,200-baud direct-connection modem. The high-speed mode, which can trim access time and phone bills, operates on the Bell 212A standard.
- Owners of the popular portable Osborne computer (Hayward, Calif.) can upgrade the capacity of its disc drives from 92K to 184K. A double-density kit is available from dealers for $185. PS

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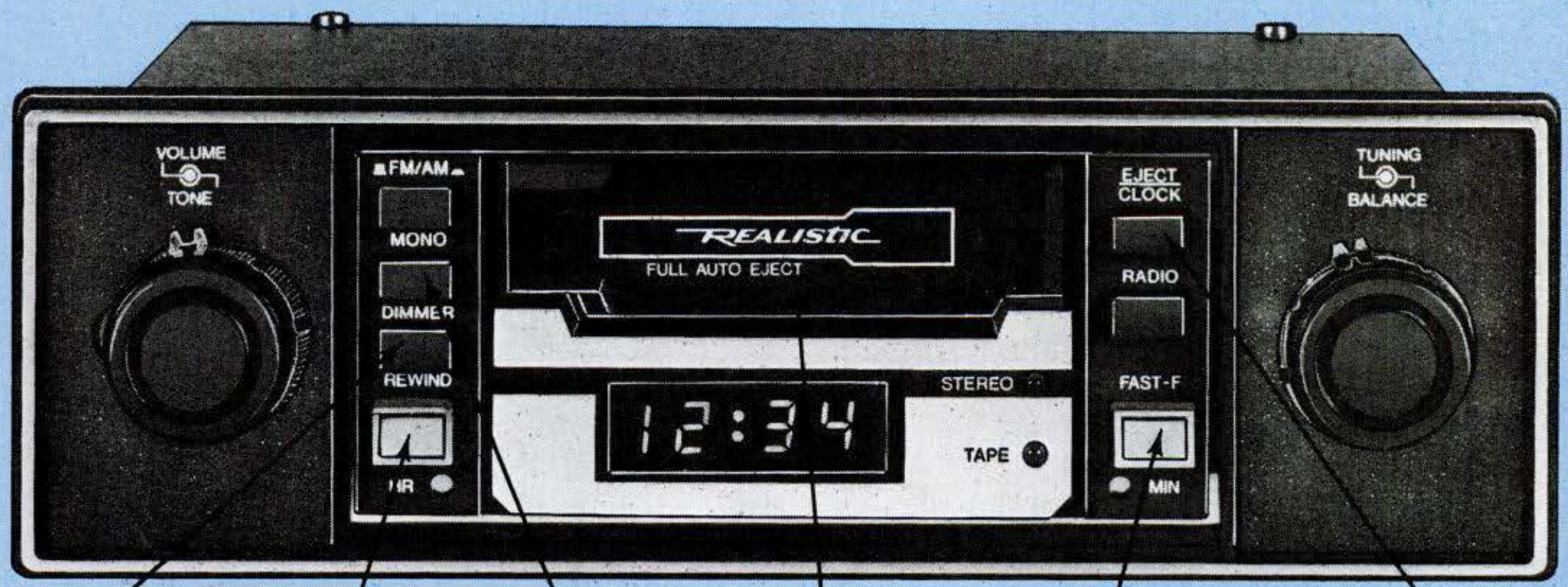

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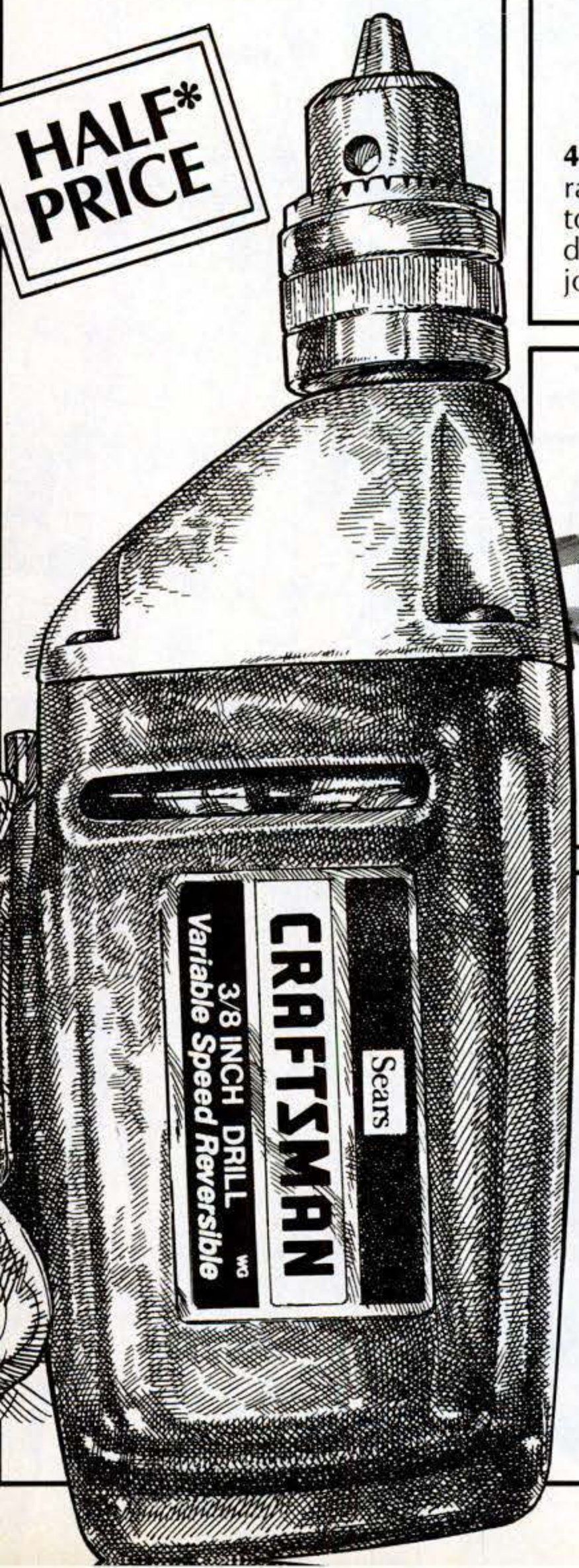

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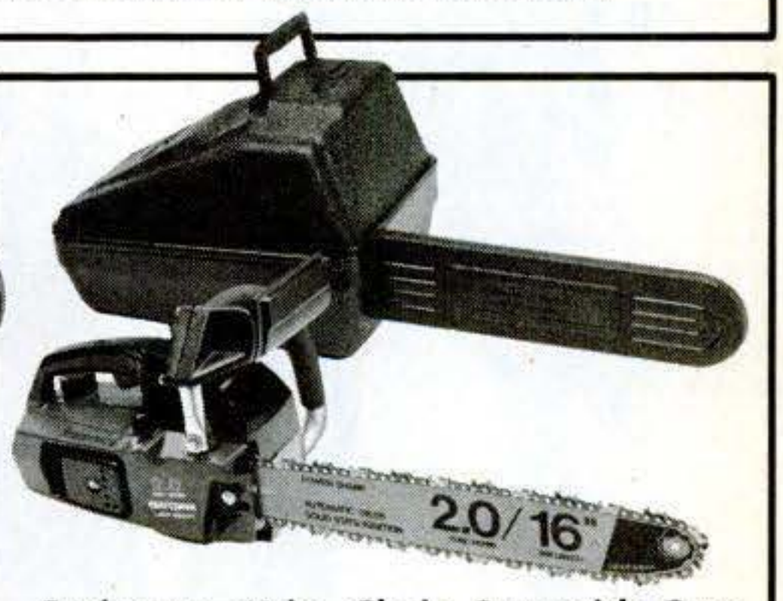

Craftsman 16-in. Chain Saw with Case (#35734) 2.0 cu. in. engine. Features Power-Sharp® built-in chain sharpening system. Solid state ignition. **Save $65.*† NOW $169.99.** On sale through Oct. 23 or while quantities last.

Craftsman Workbench (#10271) with rugged steel frame, 3 drawers, shelf and locking door. **Save $97.*†**

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(A) Black Oxford—**NOW $29.99.**
(B) Black Shoe—**NOW $34.99.**
(C) Black Boot—**NOW $39.99.**

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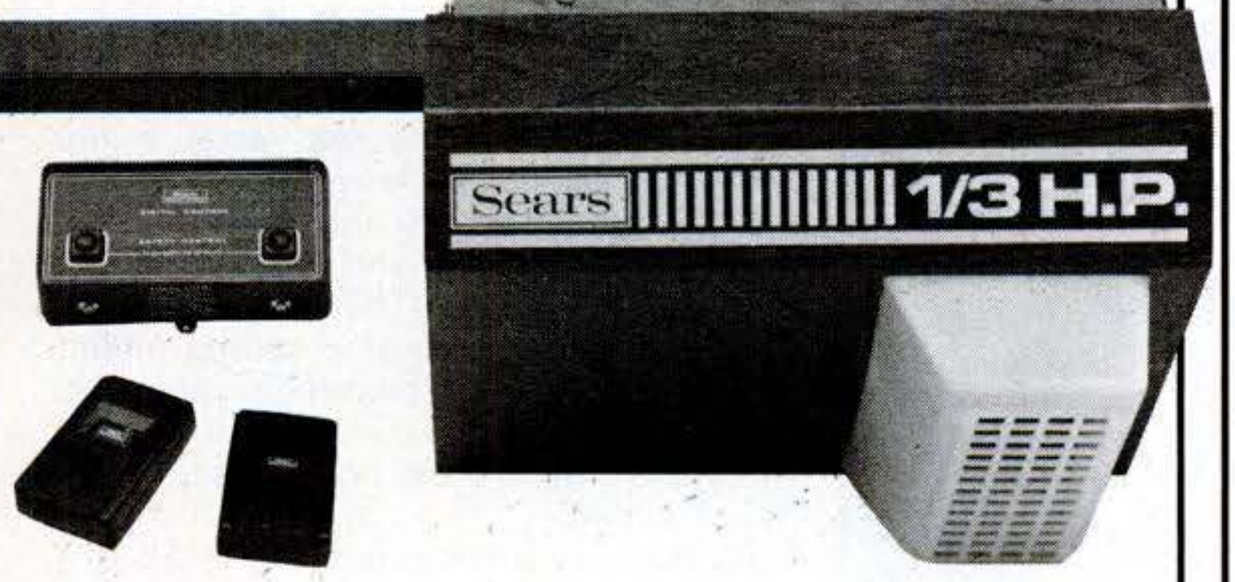

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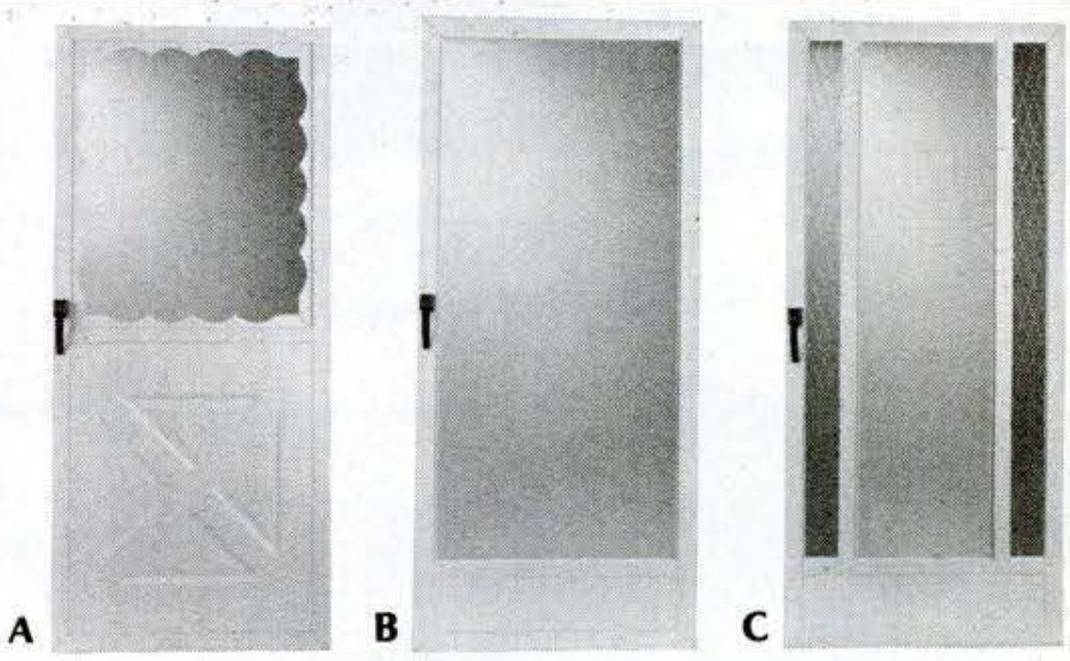

Sears Premium Storm/Screen Doors.

These doors offer attractive styling and features that provide durability, security and insulation. Foam-filled plastic core, massive keylock latch and deadbolt. Two sizes 32 x 80 in. and 36 x 80 in. Choose from three styles. Price can be applied toward computing energy tax credit.

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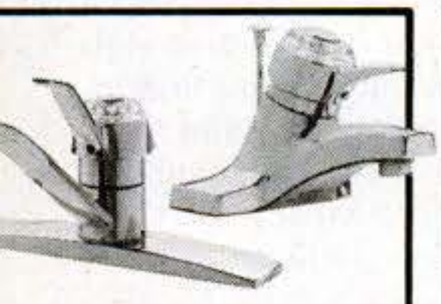

Sears Best Washerless Single Control Faucets (#20781), (#21943) 10-yr. limited warranty on parts.*
On sale through Oct. 23.
* If faucet leaks or drips within 10 years, return for free replacement parts.
Save $20 each.*
Both $29.99 each.

Power Miser™ Water Heater Insulation Jackets. Fits up to 52-gal. R-6 Insulation. Price can be applied toward computing energy tax credit. **Save $5.*** On sale through Oct. 23.

FOR ELECTRIC WATER HEATERS (#1722) **$12.99**

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Energy Saving Thrif-T Thermostat (#9100) with Triple Set back. Available while quantities last. Price can be applied toward computing energy tax credit.

SPECIAL PURCHASE NOW $39.99

Kenmore ½ HP Disposer (#6754) Stainless steel grind chamber. Quick mount collar. Available while quantities last.

SPECIAL PURCHASE NOW $69.88

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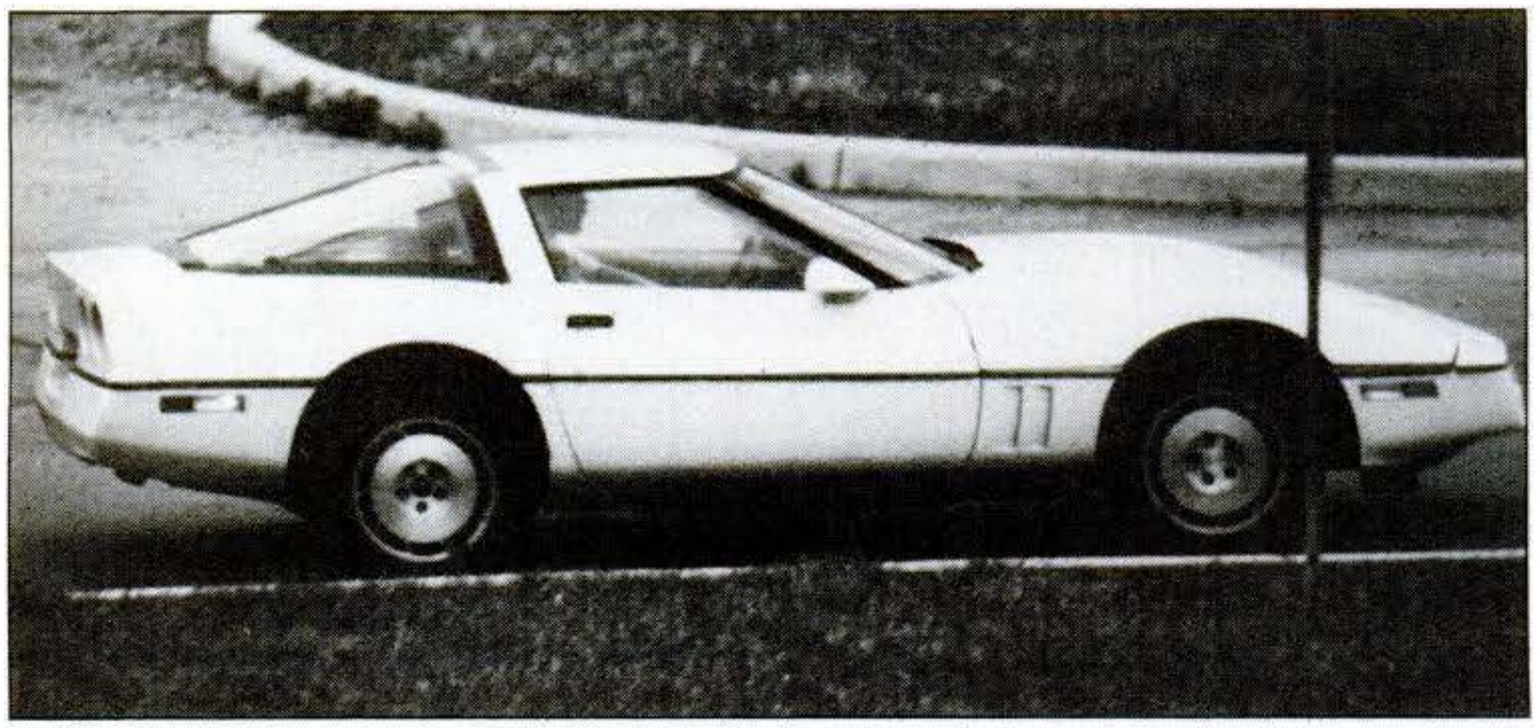
DETROIT REPORT

By JIM DUNNE



'83 Vette styling

Pictures of the 1983 Corvette do not fully convey the differences in its styling compared with the 1982 model. The new car is more wedgelike, which is apparent when the car is viewed close up. One of the most easily identifiable new features is the high rear deck. It's almost on the same level as the roof, though there's plenty of back window for rear vision. The design of the one-piece front body assembly, which includes hood, fenders, and grille, is not obvious at first glance, either. It's supposed to guarantee a smoother surface finish as well as much better access to the engine compartment. The A post has a sharper angle, and the sail panel is angled toward the rear at its base, unlike the upright sail panel on the current Vette. Special high-performance wheels and tires, which will be unique to the Corvette, are other items that become obvious only on close inspection.

P gets green light

Look for Pontiac's unusual midship-engine P-car to hit the streets a year from now. The two-seat sports car is in the GM master schedule and, after several delays, has been given the final go-ahead. The car will be built in Pontiac's home plant in Michigan on a special assembly line laid out to handle the P's plastic body and unique adaptation of the Phoenix engine and drive train. The base engine will be the Pontiac 2.5-liter four with fuel injection. Like the Phoenix, the engine and drive train are transverse, but in the P-car the engine location is amidship and drive is to the rear wheels. Because the engine is set slightly ahead of the front wheels in the Phoenix, it will be slightly ahead of the rear wheels in the P-car. This should provide excellent weight distribution. The car is smaller than Corvette and will be half the price of the '83 Chevrolet sportster. That translates roughly to $12,000.

There is also the exciting possibility that the P-car will have Chevy's 2.8-liter V6 as a performance option. That would power it into the under-10-second zero-to-60-mph-acceleration class.

AMC four-cylinder

AMC plans to phase in its own 2.5-liter (151 cu. in.) four-cylinder engine over the next six months and gradually replace the Pontiac 2.5-liter four it now uses in many models. The new engine is a shortened version of the AMC in-line six (258 cu. in.) and uses many of the older engine's parts. Its block and head are iron, but it has many aluminum accessory covers. By the time the new XJ Jeep is introduced next winter, the AMC four will be ready.

Getting competitive

Ford's most exciting new cars may make their appearance next spring when the Tempo/Topaz line is introduced. These models are completely new front-wheel drives that will compete with GM's X-cars and Chrysler's K-models. Ford's are compacts, with a wheelbase of just under 100 inches. For comparison, Reliant has a 99.9-inch wheelbase and is 176 inches long. Tempo/Topaz will weigh less than 2,350 pounds, and 1.6- and 2.3-liter engines will power it. All this means that Ford will have cars that can compete in performance and fuel economy with the best of the American models and many of the imports.

Remember CVT

You'll be hearing a lot about continuously variable transmissions in the coming months, so get used to seeing the identifying initials—CVT. This is the transmission that combines the efficiency of manual types with the smoothness and power multiplication of the automatics. GM and other auto makers agree that it is the transmission of the future for fuel-efficient cars. The name refers to the transmission's ability to provide an infinite number of gear ratios within its range, instead of the three, four, or five speeds used in current transmissions. GM is committed to CVT in Europe by 1985. Domestic buyers should see it within a year after the European introduction.

Styling challenge

How can you make small, practical cars look exciting? That's the latest major problem facing auto designers. The three-box design is efficient and became popular when efficiency and small size first became important. (The first box is the front fenders and engine compartment; the second is the passenger compartment; the third is the trunk.) But the look is tiresome when seen on virtually every small sedan.

Now the entire auto industry is taking a big hint from the sales success of the new Camaro and Firebird. Car makers believe that the best remedy for sagging sales is a fresh appearance that creates excitement. Practical designs are on the back burner until the next fuel crunch. Look for convertibles and swoopy lines for '83.

Oh, shut up

Talking cars are a novelty that will wear thin in a short time. That's my reaction after sampling the oral-warning instrument panels from Ford and Chrysler. In the first place, the messages are too long. "Please fasten your safety belts" could be shortened to "buckle up," without any loss in meaning. Also, Chrysler's synthesized voice is too loud and formal. Repeating the message is not necessary, either. Personally, it makes me want to defy the instructions. Finally, the polite machine-generated "thank you" after you do buckle up is absurd. Best news: Chrysler is weighing a voice-volume control that will reduce the sound—or shut it off completely. Look for it soon.

Future Chryslers

Chrysler officials admit that there is a sameness in the styling of its sedans this year, but next year things will be different. Then, Chrysler will have a mini-van and a two-door sports car that will feature styling unlike anything in the present lineup. The two have front-wheel drive and four-cylinder engines. The K-car transaxle will be adapted to both vehicles, and the standard 2.2- and 2.6-liter engines will be used. The van looks like a sure winner, since it is smaller outside than current passenger vans yet big enough inside to carry eight passengers. Also, Chrysler says it will compete with some small sedans in fuel economy and could top 20 mpg in city driving. The sports car will feature smooth aerodynamic styling that should contrast sharply with Chrysler's boxy-looking passenger cars. PS

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It's time to stop the space retreat

On the 25th anniversary of Sputnik's launch, America's space effort is faltering badly

By JIM SCHEFTER

Sputnik I stunned the world on October 4, 1957. For the next three months, until the 184-pound sphere fell out of orbit and burned in the atmosphere, the Russian satellite was a fiery needle piercing our national consciousness. The space age had been born. Its parents were Russian.

Like no other event in history, Sputnik triggered a change in our perception of humanity: The human spirit broke free of one small planet and moved boldly, yet with awe, into a vast, new beyond. It also triggered the most productive competition in human history, a space race more for glory and goals than riches and conquest. Nourished by dreams of adventure, the race matched the best of American technology and dedication against a Russian challenge that was definitely not just boast.

Never was a race run so fast. Less than 12 years after Sputnik, Neil Armstrong walked at Tranquility Base. "Did we do it right?" Christo-

Continued

From the perspective of 25 years ago, today's space missions would have sounded like pure fantasy: Space shuttles land in American deserts. Automated supply pods restock Russian space stations. Voyager flies on toward Uranus. Venera lands on Venus. But in America of the 1980's, hardly a head turns. Public attitude is reflected in the struggling U.S. space program—or maybe vice versa. The once-bold American adventure in space now seems timid and halting.

The editors of POPULAR SCIENCE *are alarmed by this state of affairs. We believe that this nation and mankind in general must move strongly ahead in space. Now, scattered stirrings from around the country suggest that a great many people—private citizens, scientists, space professionals, and elected officials—agree. To find out what can be done to stop the decline of the space program, we assigned veteran space reporter Jim Schefter—on the beat since the Gemini years—to sound out leaders across the country whose jobs and opinions strongly influence national space policy. Here is his report.—The Editors*

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[*Continued*]

pher C. Kraft asked, pacing his top-floor office at the Johnson Space Center in Houston. "I don't know. Did we do it well? Yes. Absolutely!"

But now, as we enter the second quarter century of the space age, the great dreams of only yesterday have turned to dust. The U.S. space program in the 1980's is an ambiguous hodgepodge of brilliant events, great potential, unkept promises, and downcast vision.

There is no lunar colony. No astronaut will land on Mars in this century. No program exists to send new U.S. craft to Venus or Saturn. What seemed to be America's manifest destiny could be slipping out of reach.

This is a national tragedy. We des-

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Jan. 4, 1970. With President Nixon's approval, NASA cancels Apollo 20. The decision frees a Saturn 5 booster needed to launch Skylab in 1973.

Sept. 1, 1970. Nixon announces cancellation of two more Apollo missions to the moon, reducing budget pressure to allow pursuit of a space shuttle.

Feb. 1, 1971. NASA cancels the Grand Tour program intended to send spacecraft through the outer solar system. Less-capable Voyager craft ultimately accomplish many Grand Tour goals.

Jan. 5, 1972. After two budget-induced redesigns, Nixon gives scaled-down space shuttle final approval.

Dec. 19, 1972. Splashdown of Apollo 17 ends manned moon exploration.

Aug. 15, 1973. With estimates for the shuttle soaring, NASA kills plan to launch a second Skylab. The craft and its fully operational Saturn 5 boosters eventually become museum exhibits.

July 25, 1975. Apollo-Soyuz ends; last American in space until shuttle flies.

Oct. 1, 1977. NASA can't afford to continue receiving and studying scientific data from remote stations left on the moon by astronauts. On signal from Houston, the stations are turned off.

July 11, 1979. Skylab falls over western Australia. U.S. has no plans to pursue building of a space station.

January 1980. Galileo mission to Jupiter is scaled back, delayed to 1985.

Aug. 7, 1980. Radio command from Jet Propulsion Lab shuts off Mars-orbiting Viking craft after more than four years of studying the planet.

January 1981. President Carter continues to defer decision on mission to Halley's comet, but a Venus radar mission gets tentative approval.

March 8, 1981. The Reagan Administration cancels participation in International Solar Polar Mission. Spacecraft were already under construction.

April 12, 1981. Space shuttle flies.

February 1982. Venus radar mission and Halley's mission are dropped.

July 4, 1982. In a major space-policy address, President Reagan fails to make a commitment to build a space station.

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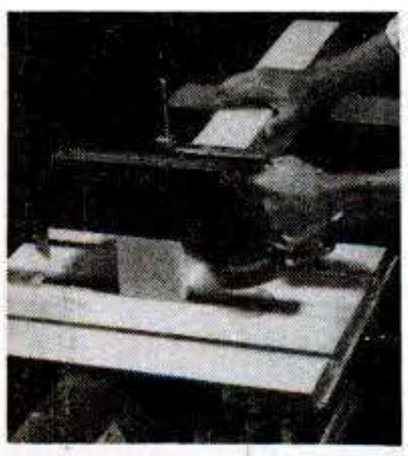
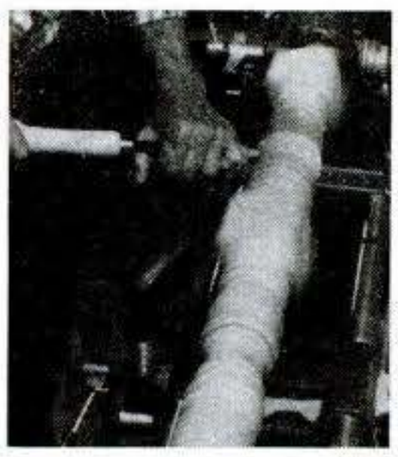
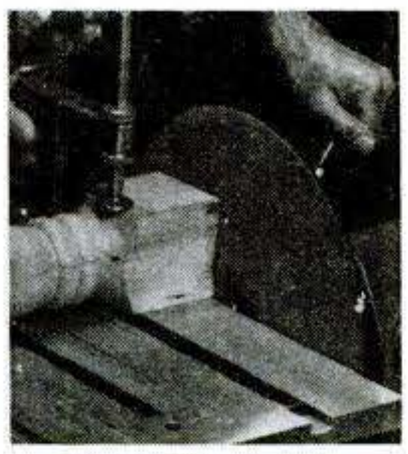
What makes this one machine a better buy than a whole workshop full of costly single purpose tools?



The Shopsmith MARK V is a remarkable woodworking "system" that can save you money, time, work and valuable workshop space. This one versatile machine is a combination of the five basic woodworking power tools into one easy-to-use, compact unit that requires no more space than a bicycle!

But aside from being the unique and original "room-full" of tools, what makes the MARK V the **better buy** for you? Here are just a few good reasons:

The tool to start with... the system you grow with.

You get the flexibility of several power tools at considerably less cost!

Single purpose tools are just that... limited to only one function. That means you spend extra dollars on more motors, more pulleys, more stands... and that means higher costs and added repair headaches.

In comparison, the Shopsmith MARK V is a sturdy yet mobile freestanding unit with **one** rugged, precision-built motor to power **all five functions —**

- 10" Table Saw • 16½" Vertical Drill Press
- Horizontal Boring Machine • 34" Lathe • 12" Disc Sander

You get consistent accuracy and precision!

Because of the MARK V's unique "shared features", tolerances **never vary** from one tool setup to another. You can saw, then sand and drill all at the same angle. Take a close look at a piece of fine furniture... you'll see the importance in the type of precision the MARK V features. (Plus, you'll appreciate the savings of time, materials and labor.)

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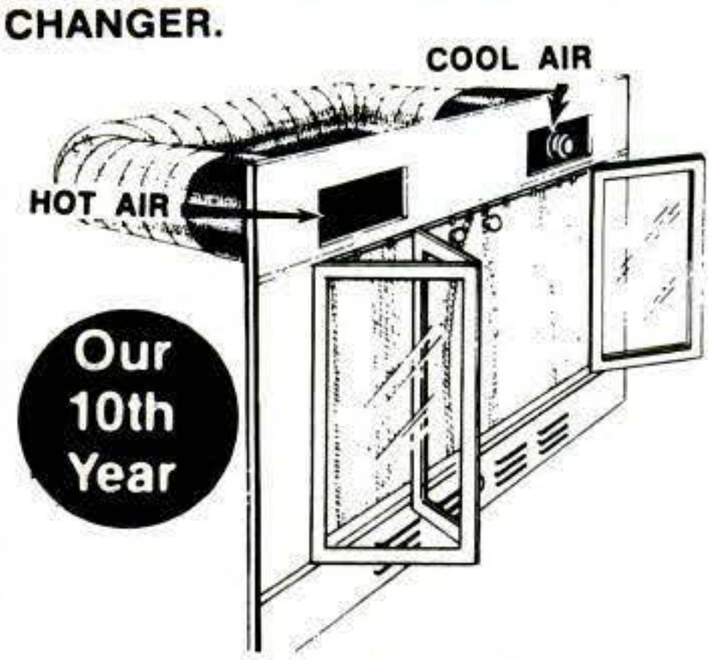

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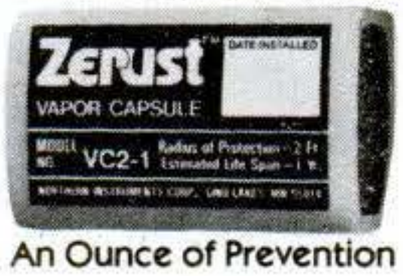

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perately need to get the space program back on track, for vital and historic reasons:

Economic benefits. What began as a bid to boost national morale by one-upping the Russians turned out instead to have enormous economic impact. Orbiting satellites, sophisticated descendants of Sputnik, have totally transformed the way we pursue commerce—in every field from communications to farming to weather forecasting and much, much more. What economic benefits will future space-technology advances bring? Energy from space? Minerals from the moon and asteroids? Factories in Earth orbit? All are within reach. Each can be at least as important as benefits we already take for granted.

Space-technology spinoffs. Fundamental advances forged for the space program and adapted for earthbound uses have changed our world in many ways. Computer technology, at the heart of almost everything we do, reached its current state because of space-program catalysts. New products and techniques in fields from metallurgy to lubrication, from chemistry to medical monitoring, have immeasurably improved the quality of our work, our homes, and our lives. The money was spent in the name of space, but the benefits have reverberated across every aspect of society.

Basic science. The human mind has a need to know, and the space program—with its brilliant forays to the corners of our solar system—has pushed forward the quest for knowledge more rapidly than any research program in history. But for every question answered, dozens more have been raised. The need to seek and to probe never ends.

National defense. Centuries ago, defense efforts moved out from national boundaries to encompass the oceans, and the powerful navies of the world were born. Now, defense is moving into the oceans of space. Whether this new arena will be limited to such military-support purposes as reconnaissance and communications or ever will become the literal high ground of future wars, can any first-rank power fail to prepare?

Quadruple threat

The conquest of space is a complex undertaking, requiring ever more advanced technology. That technology cannot be allowed to languish, then be developed on demand at some later

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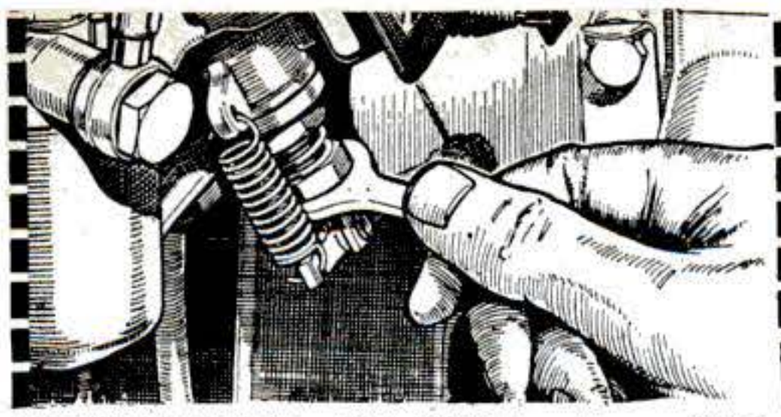

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date. It must be advanced in a logical, orderly manner. To stop now—or to limp along at an inadequate pace—imperils the future. It threatens a loss of leadership not just in space but in practical technology, science, and military power, as well. Yet this is the future we face.

What went wrong? Why did it happen? And most important, what needs to be done now in order to reverse the decline?

The seeds of our current predicament go back more than a decade. Even as the world celebrated America's remarkable moon landing in 1969, shrinking budgets and self-doubt began gnawing at the future of the U.S. space program. The thirst for knowing the unknown was slaked—if not quenched—on lunar plains and Martian deserts, in Venusian clouds and at Saturn's razor rings.

NASA's combined spending for the 24 years from 1959 through 1982 totals just $90.1 billion, a few months' budget today for Social Security or the Department of Defense. For the NASA investment, we built permanent space centers; bought all of the manned programs, including Apollo and the shuttle; explored the planets and the space around Earth; and more. But the chronology of missed deadlines and canceled projects (see box) began the year following Armstrong's walk and continued throughout the 1970's.

Buck stops there

Much of the criticism for the decade-long decline focuses directly on past occupants of the White House. Lyndon Johnson began trimming NASA's budget almost immediately after taking office, and other presidents have had other priorities.

Says Dr. Bruce Murray, former director of the Jet Propulsion Laboratory in Pasadena, Calif.: "There's been a loss of presidential vision and ability to deliver ever since Watergate. Nixon made the decision to go ahead on the shuttle, and there's been nothing of importance in the 10 years since. Ford wasn't around long enough to have any effect, and Carter was pathetic, just pathetic."

It sounds harsh, but others agree. "We've had chief executives who are not familiar with space surrounded by people who are crisis managers," said U.S. Representative Don Fuqua, chairman of the House Committee on Science and Astronautics. "The combination doesn't create vision."

"After Apollo, we reverted to a more parochial set of visions," said Robert Walquist, vice-president and general manager of TRW's Space and Technology Group in Redondo Beach, Calif. "We retreated from what we could do and what we are able to do."

The Reagan administration demonstrated its lack of vision by issuing a space policy directive July 4, 1982, that does nothing to improve the pessimistic picture. In a so-called major statement at Edwards Air Force Base, Calif., following the fourth landing of the space shuttle Columbia, Reagan chose to speak of philosophies rather than deeds, and to avoid any new commitment in space.

If lack of leadership is the underlying reason for the space retreat, the shuttle excepted, the surface cause is lack of money. "Even the shuttle was under-funded by a factor of two for years," said Senator Harrison H. (Jack) Schmitt, the only U.S. lawmaker to have walked on the moon. "It forced NASA to keep slipping major milestones in order to have the money to handle current problems. It's one of the major ironies of history that Jimmy Carter saved the shuttle because he wanted SALT II [Strategic Arms Limitation Treaty] ratified. [The shuttle would launch the reconnaissance satellites needed to verify treaty compliance, but the treaty remains unratified.] He finally authorized a major increase so we could buy our way through the milestones."

Out with a whimper?

But by then, the Nixon-Ford-Carter attitudes had sent the overall U.S. space program into a major decline. "We were just coasting compared with what we could have done," Schmitt told me. "Three Saturn 5's lying on their sides is a sad commentary, and so is Skylab flight hardware on display in the Smithsonian [see box]."

NASA's major achievements of the last decade—having a single Skylab briefly in orbit, landing robot ships on Mars and Venus, flying past Jupiter and Saturn—had their beginnings in the late '60's or early '70's and have virtually no counterparts in the '80's. The once-spectacular U.S. planetary program is all but dead.

The only new effort still surviving is Galileo (artist's concept, opening page), which will launch craft to Jupiter in 1985, arriving in 1987. Voyager 2, launched in 1977, will get to Uranus in 1986 and may be retargeted to Neptune for a 1989 arrival. Two even more ancient Pioneers will continue to transmit as they move toward the edge of the solar system (where their data now hint at discovering a tenth planet or a dark companion to our sun). Another Pioneer, launched in 1978, still orbits Venus, chattering its findings home. That's all there is.

"Planetary exploration was a fallout of Apollo," said Bruce Murray. "We responded to the Soviet challenge with the greatest technological endeavor ever undertaken. We won, and there was no doubt that we won. But now that string has run out. The momentum is gone. I think the Apollo program happened about four decades too early."

Current NASA Administrator, James Beggs, thinks the Reagan administration will eventually make the right moves. "Still, there's always the danger of a political force putting an end to something," he mused as we talked in the agency's Washington headquarters.

The Reagan political force did put an end to the International Solar Polar mission before Beggs arrived, and then to the Venus Orbiting Imaging Radar spacecraft. "They made some mistakes early on," Beggs said. "The budget cutters rushed in on Solar Polar without giving it serious consideration." That was a decision that angered much of the space community. "We, as a country, reneged on an agreement that we'd made with our European partners," TRW's Walquist said. "We insulted them. We just did it without even consulting them."

The Venus decision was based on money alone. "We did nail the mission, and I regret it," Beggs told me. "It was a good mission, but we couldn't fit it into our budget." Beggs excuses Reagan from responsibility for another retreat—our failure to fund a mission to Halley's comet. "That one was a Carter fumble," he went on. "Now should we whomp up a mission just to say we went? Not when there's no time to do meaningful science."

It can easily take six or more years to design, build, and launch a planetary spacecraft. So the low point of the U.S. space program, in the eyes of the world, could come in 1986 when four sophisticated spacecraft carrying the flags of the U.S.S.R., Japan, and the European Space Agency nations visit Halley's comet. The two Soviet ships will do double duty by dropping probes off at Venus on their way to cometary encounter. NASA and individual U.S. scientists are contributing to the Jap-

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anese and ESA programs, but little of the prestige and acclaim will rub off on America.

Even worse, all in the name of money, Beggs cut back on the number of space-shuttle missions planned through the mid-1980's and increased NASA's future fees for orbiting satellites by 85 percent. Those moves may help Europe's Ariane [PS, July '80] program, which competes with the shuttle for space-launch business.

"We are falling behind," Don Fuqua noted. "The real void will show up in the 1990's. To have meaningful missions in the '90's we have to start now."

Signs of recovery?

Beggs has ordered a new plan for planetary exploration to be ready in 1982. It likely will include a simplified Venus radar mission. That should please such vocal scientists as Bruce Murray; Dr. Carl Sagan, currently president of the Planetary Society; and Dr. James Van Allen, whose public pressure last spring stopped NASA from terminating the Pioneer 10 and 11 deep-space missions.

The turnabout will be a slow process, but Beggs thinks that it has already started, pointing out that NASA's 1983 budget of about $6.1 billion, the first completely under Reagan, reflects an 11 percent increase. Included in that is a big jump for space science. Beggs pushed hard for the latter, contending that "understanding the environment around Earth and finding new ways and new ideas for using applications satellites like Landsat are absolutely essential."

Even with the increases, 30 percent of the Jet Propulsion Lab's work has been shifted over to military programs, and director Murray has resigned to try new challenges, including writing. He praises the shuttle faintly in parting: "What's indefensible is sacrificing the rest of the civil space program to do it," he said tightly. "We could have taken that step and avoided the sacrifices."

The painful sacrifices of the '70's were not shared by the military. With NASA bearing the brunt of shuttle-development costs, the Department of Defense moved ahead sharply in the decade with top-secret surveillance systems, sophisticated weather and communications satellites, advanced navigation satellites, and construction on a second shuttle-launch base at Vandenberg AFB in California.

Continued

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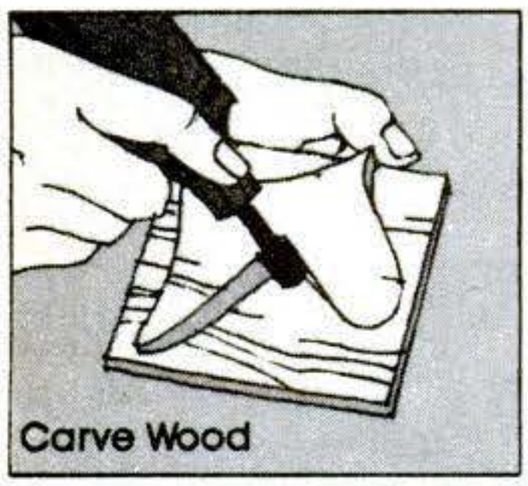

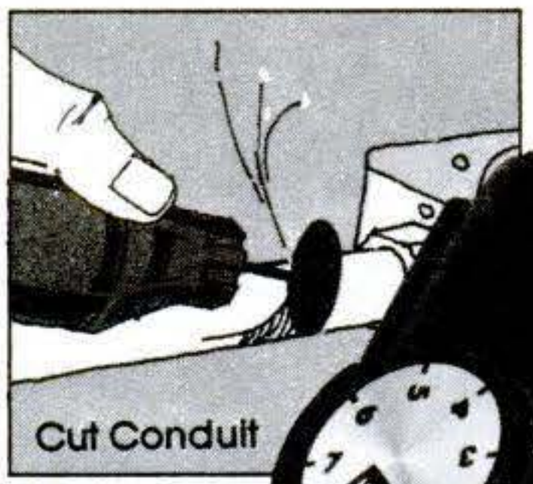

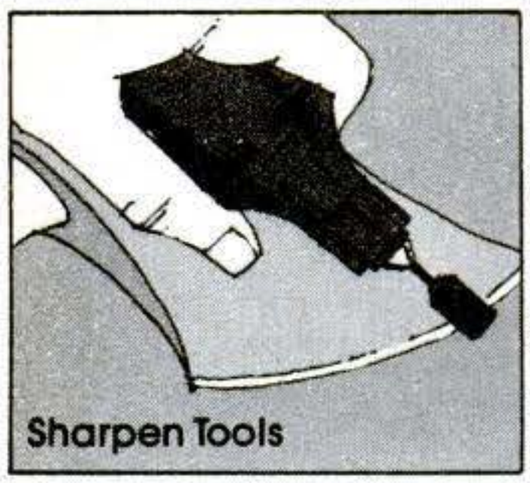

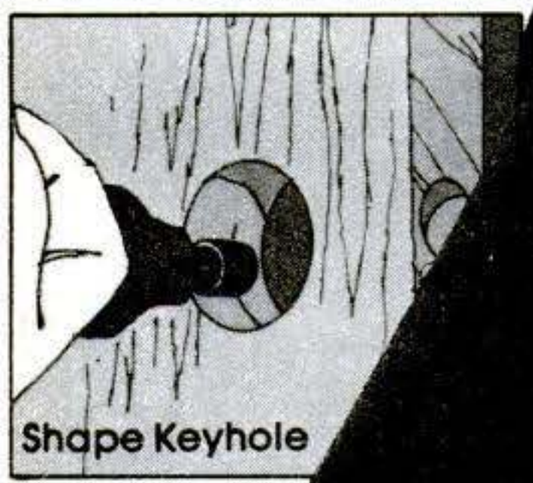

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The space retreat

[Continued]

"There's a popular feeling that the space program has lost its momentum," said Brig. Gen. Bernard Randolph, director of U.S. Air Force Space Systems. "But it's just not true."

From his Pentagon vantage point, Randolph is correct. In the current year, military space spending will hit $7.5 billion, nearly 25 percent more than NASA's budget. A classified payload already has been carried in the shuttle, and others are in development. So is a new super communications satellite system called MILSTAR. A military-only control-center complex will be built near Colorado Springs, and the Pentagon is actively backing proposals for a permanent space station.

The whole question of the military in space also is under review. "In the past, space has been considered a sanctuary; you don't fight there," TRW's Walquist said. "But there are significant Russian advances in that direction. We have to consider space as a medium for fighting a war."

The next major push in nearly everyone's view must be for a permanent station in space, possibly to be included in the next NASA budget. Chris Kraft, the respected space veteran who rose from flight-control status in the Mercury program to head the Johnson Space Center, favors moving ahead strongly with a Space Operations Center—a large orbiting station that would become the base for nearly all future missions. For Kraft, such a station could become the centerpiece of a reinvigorated space program.

"I'm concerned," he told me. "If we don't continue to lead the world in technology, we can't compete. We need a new wave, a reincarnation of what happened in the '60's.

"We've got the experience to look ahead and say where we should be 30 years from now. It's a rare capability. You can't do it in the automobile or aviation industries. But you can do that for space.

"It's time to set our main course," Kraft insisted.

Next logical step

The course starts with the $15 billion Space Operations Center, a price tag that even spread over a decade sends politicians scurrying for cover. Alternative concepts involving modular expansion and lower costs are getting serious consideration.

The military is a strong space-station backer. "We're working closely with NASA, with suggestions for Air

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Force use," Gen. Randolph told me. "If it goes ahead, it will have to be a joint project."

One expert who questions the need for a space station is Dr. Frank Press, Jimmy Carter's science advisor and now head of the National Academy of Sciences. "I haven't seen any justification for it yet," he said. "What will they do with it? What applications do they have in mind? I'm open, but I'm not yet convinced that it's a good use of our federal resources."

The Russians made the commitment to space stations years ago. They repeatedly send crews, including "guests" from France, Mongolia, Czechoslovakia, and other selected countries, to their small Salyut stations, and they perfected a robot tug that resupplies them. They even have their own shuttle in development.

The U.S. dabbled with Skylab, then killed it in its prime. "Skylab was a major disappointment," grumbled George Merrick, looking out over Los Angeles International Airport. The seasoned Rockwell vice-president has corporate responsibilities in space operations. "We could have kept it operating yet today without major expenditures, and it would be up there now for the shuttle to visit."

> "Four advanced craft will visit Halley's comet in 1986. None will carry the American flag"

Instead, America is in the position of playing catch-up, or not playing at all. Reagan's lukewarm space policy made no mention of space stations. It hedged on specific commitments. It set no goals.

Even if a space station gets Reagan's approval, its size and functions will be an executive decision based on politics and economy. But any size station would have great potential.

One payoff would be from industrializing space. "The government must recognize that it has a critical part to play in furthering this technology," Chris Kraft said. "Private industry can't do a space program by itself. With the shuttle and a space station, we can make it a reasonable risk by providing the floor space and the transportation."

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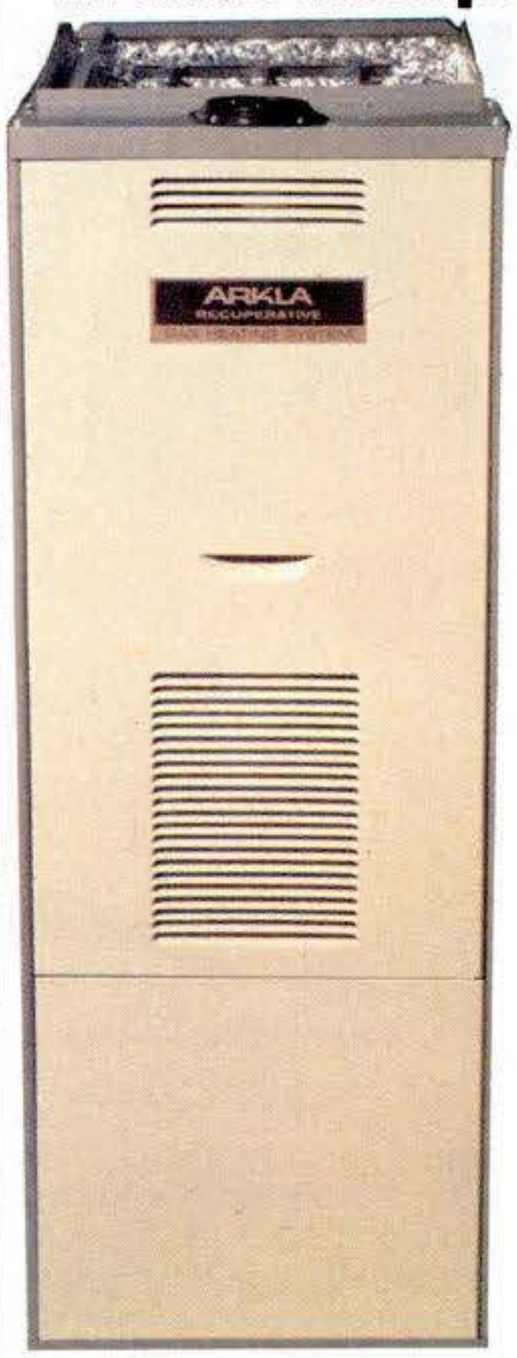

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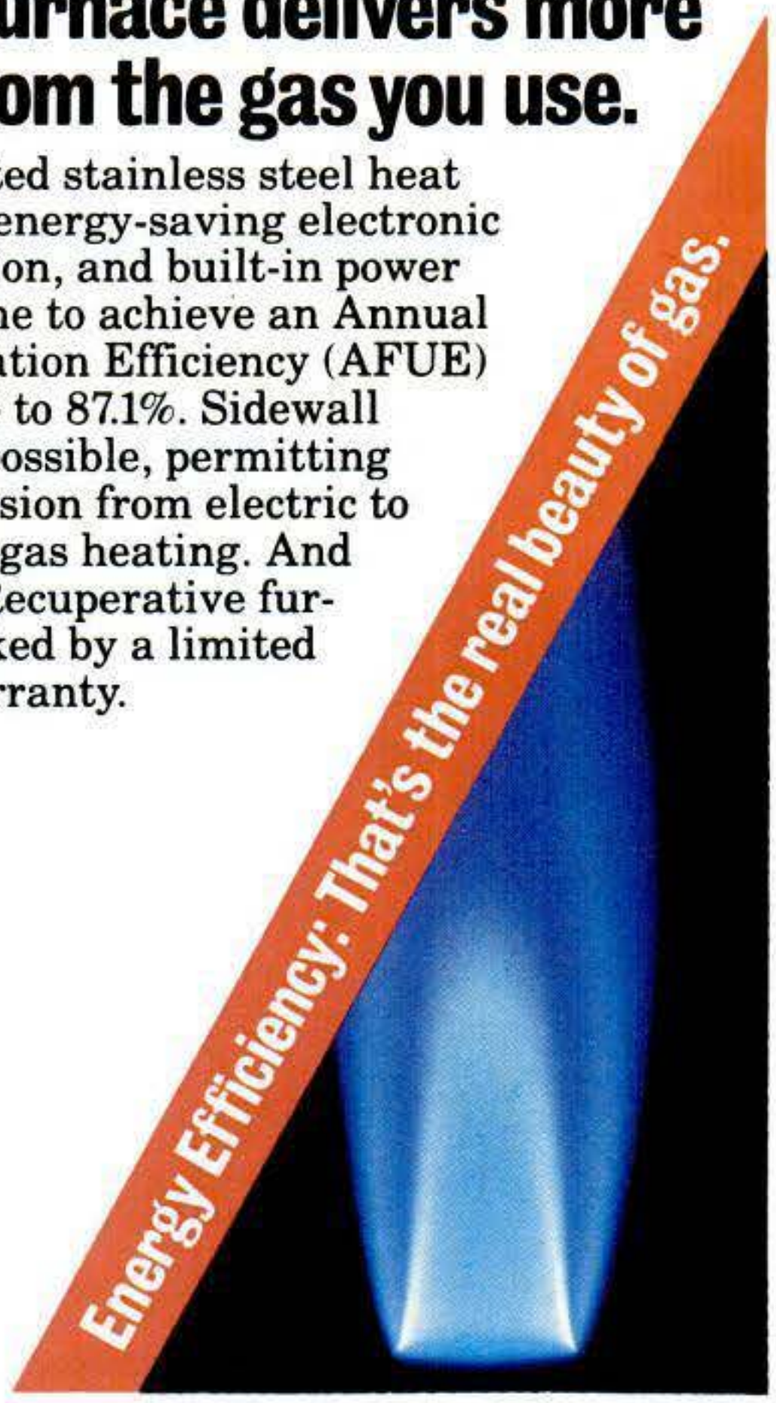

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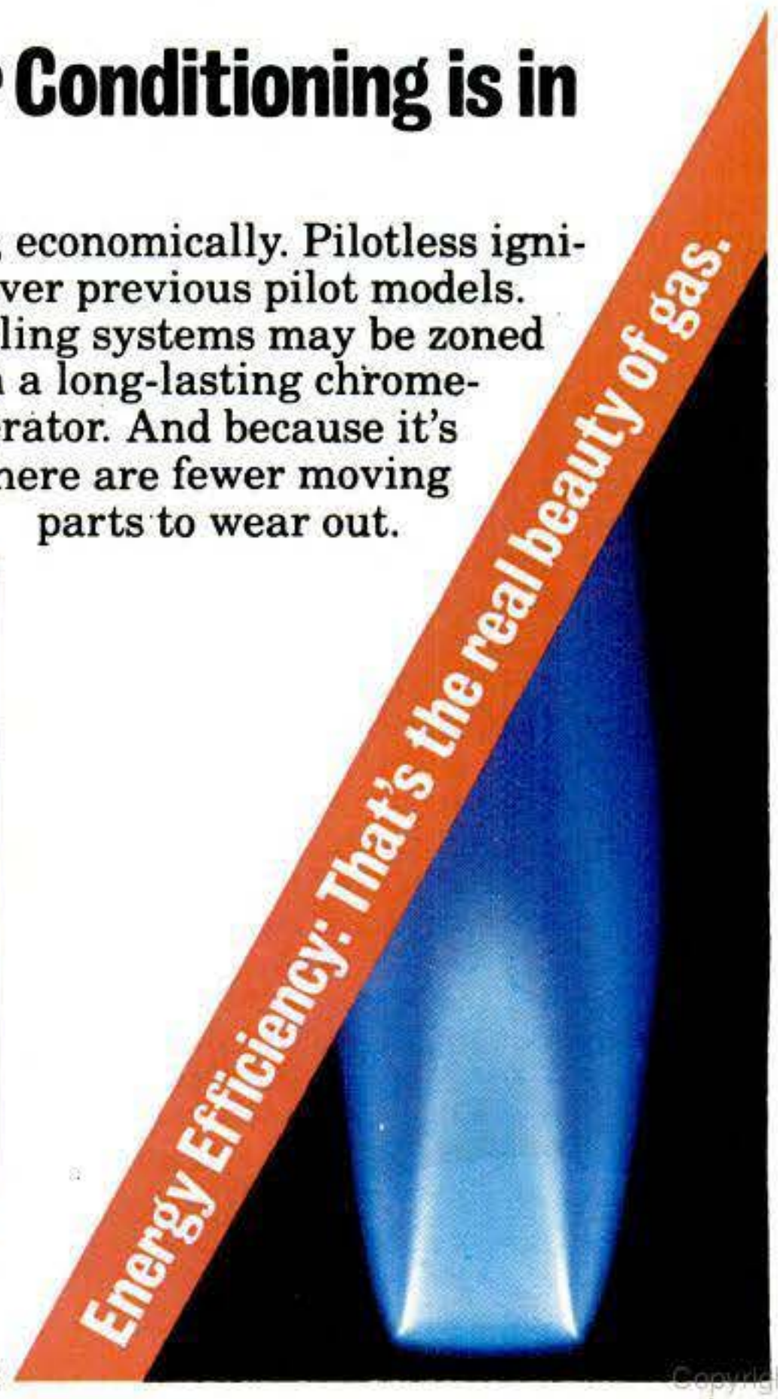

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The space retreat

[*Continued*]

Among the uses the Air Force sees for a space station is a spaceborne command and control center. Such centers already exist in wide-body aircraft, one of which is always in the air somewhere over the U.S.

Return to the planets

A space station also would have the potential to support complex planetary missions. NASA Deputy Administrator Hans Mark would put the moon and Mars high on the list for new explorations. "I'd like to see a lunar polar orbiter and a Mars polar orbiter both come soon," Mark told me, "and later, a Mars sample return staged from the space station."

"We can make the Mars expedition after we establish ourselves in orbit," Kraft said. "We have to do the economic, political, and engineering evaluations in a rational way, and there must be a literal payoff—or we ought to knock it off."

"Our future program is quite clear, but we must articulate it," Schmitt told me. "So far, the Soviet leaders have shown a much better historical perspective on space. Our imperative is to get the American station in space by the end of the decade.

"The vision is there in the public, but we have to have leadership," Schmitt continued. "We're faced with the need for decisions on space. If we back away once again, we won't have another chance."

The model for space leadership is President John Kennedy, whose pledge to "land a man on the moon and return him safely to Earth before the decade is out" brought together the money, talent, and inspiration that resulted in America's great triumph. There is broad agreement that today's space program urgently needs such an inspiration again—major new goals and a strong commitment from the president—or we risk falling into third place in space, behind the Russians and Europeans.

Through the first half of 1982, the debate over future space goals raged in the aerospace industry and in government, reaching even into the White House. By October 4, when the world remembers Sputnik's first stunning signal from orbit, crucial decisions will have been made—or will have been deferred once again for another time.

Whatever the outcome, the 25th year after Sputnik is a balance point for the United States in space.

Which way will we tip? PS

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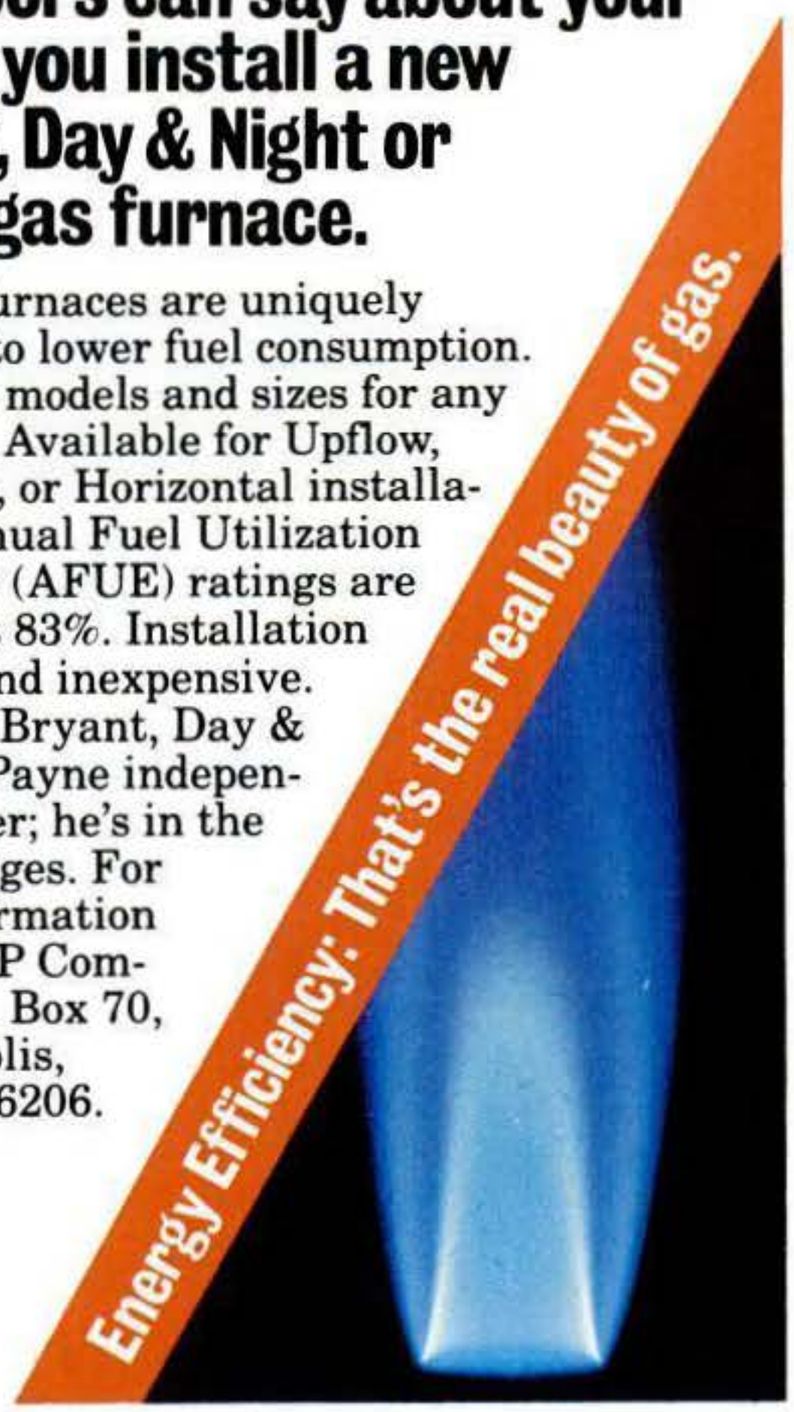
These furnaces are uniquely designed to lower fuel consumption. There are models and sizes for any size need. Available for Upflow, Downflow, or Horizontal installations. Annual Fuel Utilization Efficiency (AFUE) ratings are as high as 83%. Installation is quick and inexpensive. Call your Bryant, Day & Night or Payne independent dealer; he's in the Yellow Pages. For more information write: BDP Company, P.O. Box 70, Indianapolis, Indiana 46206.



AMERICA'S GAS BOILER

New fuel-saving Burnham gas boiler keeps heating costs down.

Burnham, America's Boiler Company, introduces the new XG-2000 gas boiler that saves energy by reducing heat loss. In fact, with Department of Energy efficiency ratings of up to 84.3%, the XG-2000 cast iron boiler is one of the most efficient you can buy.

And, with an integral trouble-shooting module that pinpoints problems at a glance, the XG-2000 combines efficiency, safety and serviceability.

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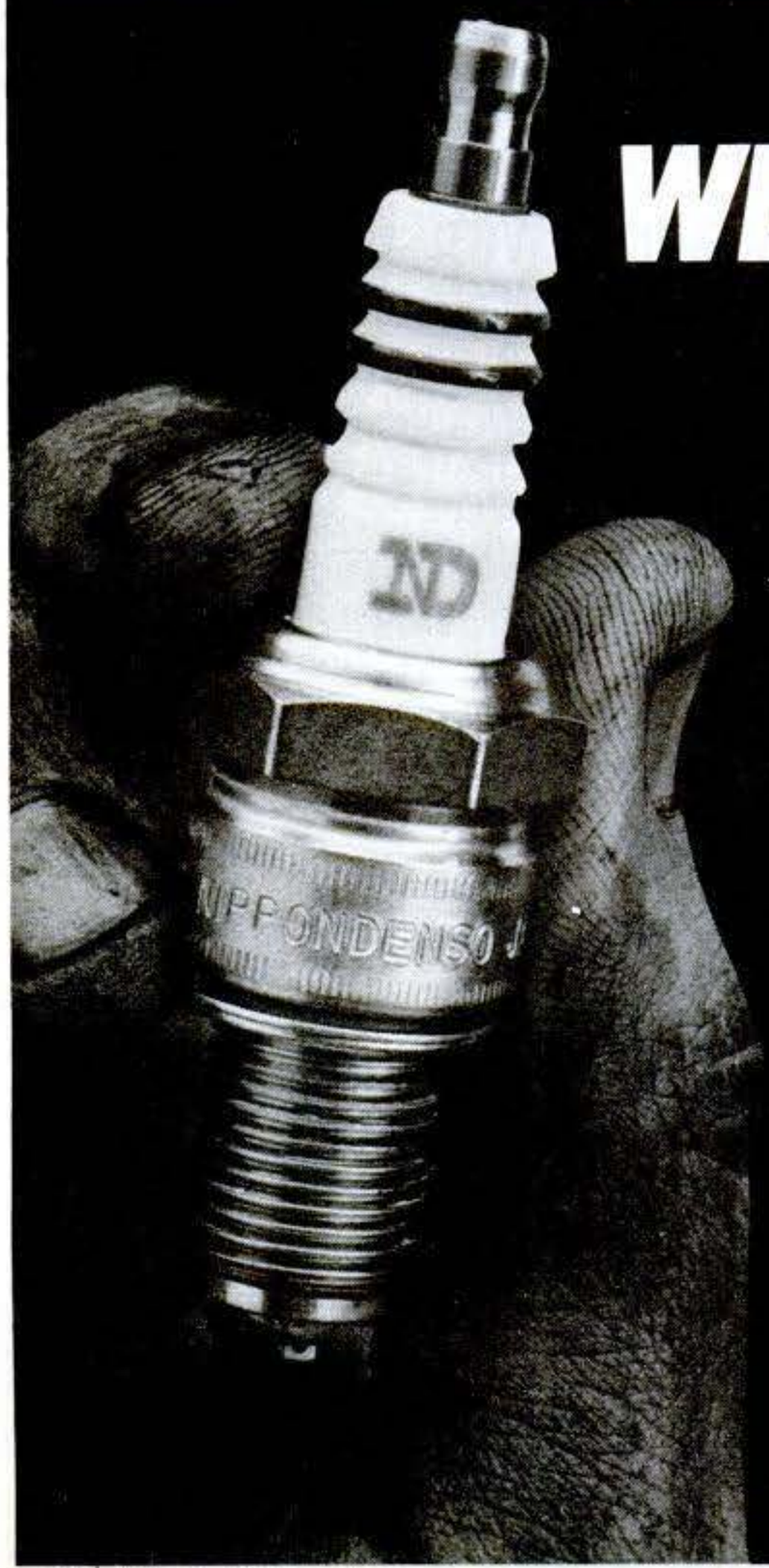
Build-it-yourself mower
makes zero-radius turns

C. F. Struck's newest assemble-from-a-kit yard machine, a 16-hp front-mount mower, not only goes forward and backward but also rotates neatly around its own center. The Mini-Skat's secret? Individual clutches to the two front wheels and the full pivoting tail wheel. Push ahead on one steering lever and pull back on the other, and around you go—without ever leaving where you were. If your mowing confronts many obstructions and tight corners, the time saving could be substantial.

Struck's heavy-duty kit components that you bolt together have been famous for durability, if not for beauty, for many years. Most of the Mini-Skat's drive parts come from Struck's Mini-Dozer, a build-it-yourself yard tractor we reported on in May 1967.

The Mini-Skat can take a 38-inch commercial-quality front mower disc, a light dozer blade, or a snow thrower. For safety, the mower blades brake to a halt in less than three seconds.

Struck expresses scorn for light sheet-metal parts. The Mini-Skat tractor alone weighs 600 pounds; the mower deck weighs 150. Sold directly from the factory, the basic tractor kit is $2,000; the mower deck costs $500. C. F. Struck Corp., Box 307, Cedarburg, Wis. 53012.—*E. F. Lindsley*



WE'RE NOT JUST ANOTHER FLASH IN JAPAN.

It's true that Nippondenso Spark Plugs are original equipment in Toyota, Honda, Subaru, Mazda, and other Japanese cars and trucks, as well as on Suzuki, Yamaha, Kawasaki, and Honda motorcycles.

But then ND plugs also meet the factory specifications for major American and European makes as well.

In fact, Nippondenso is a leader in electronics technology for just about everything that moves on wheels.

So if you thought ND plugs were just for Japanese machines... have we got a flash for you.

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The Fastest Growing Spark Plug in America.

To order any standard ND Spark Plug, send $2.05, plus .50c shipping and handling, to: Nippondenso of Los Angeles, Inc., Customer Service Dept., 857 East 230th Street, Carson, California 90745 (California residents add 6% sales tax.) Be sure to specify the make, model, and year.

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Tougher tire has woven belt

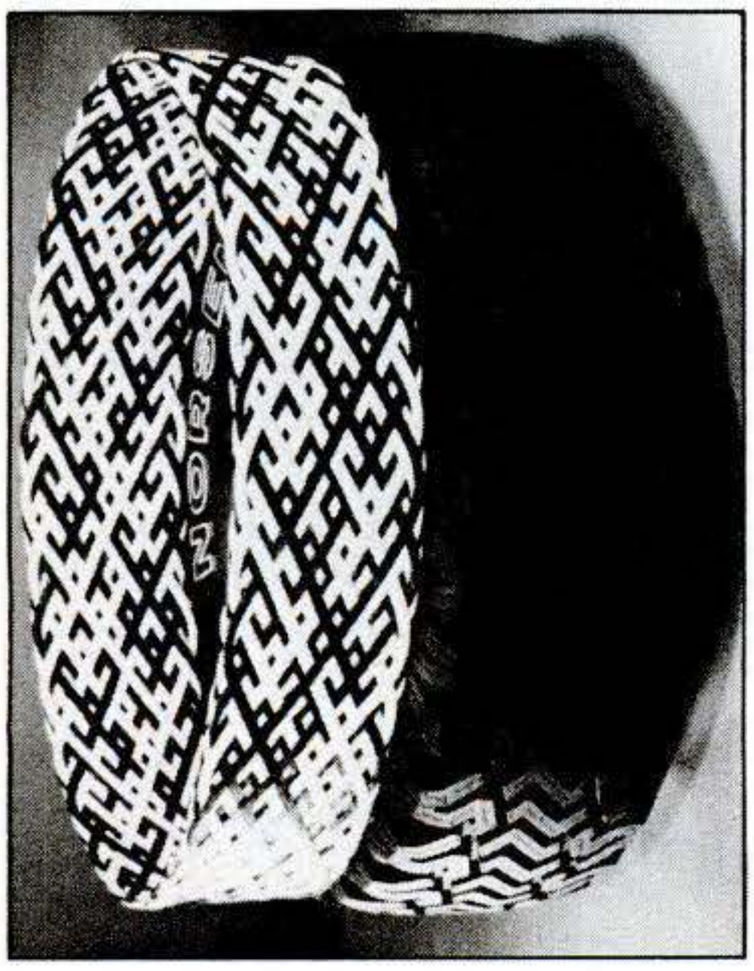
A tougher tire for off-roaders? That's what Armstrong says of its new Norseman radial. The tire incorporates an interwoven belt design called Tredloc, which makes the tire lighter, stronger, and more fuel-efficient, according to Armstrong.

In conventional cut-belt radial-tire construction, the belts run at 12 to 20 degrees across the tire center line in layers. The point at which these layers meet the sidewall is known as the belt edge. This is the Achilles heel of old-style cut-belt tires.

The new design eliminates this edge by weaving the belt layers into a closed matrix. The belt layers in the photo are two colors in order to make this difference in construction more apparent. The belt material—Du Pont's Kevlar aramid—would normally be composed of fibers of the same color. Kevlar is pound for pound five times as strong as steel. Because it's also lighter and more flexible, the tire has less rolling resistance, hence better fuel mileage.

This flexibility, plus the woven belt design, enables the tire to "engulf" road debris and surface irregularities for a smoother ride, Armstrong claims. RV owners and off-roaders will be pleased to know that the tire also shows greater resistance to heat-related deterioration caused by overloading or under-inflation.

Now for the bad news. It'll cost 78 percent more than an aramid cut-belt tire, says an Armstrong spokesman.—*Jack Keebler*



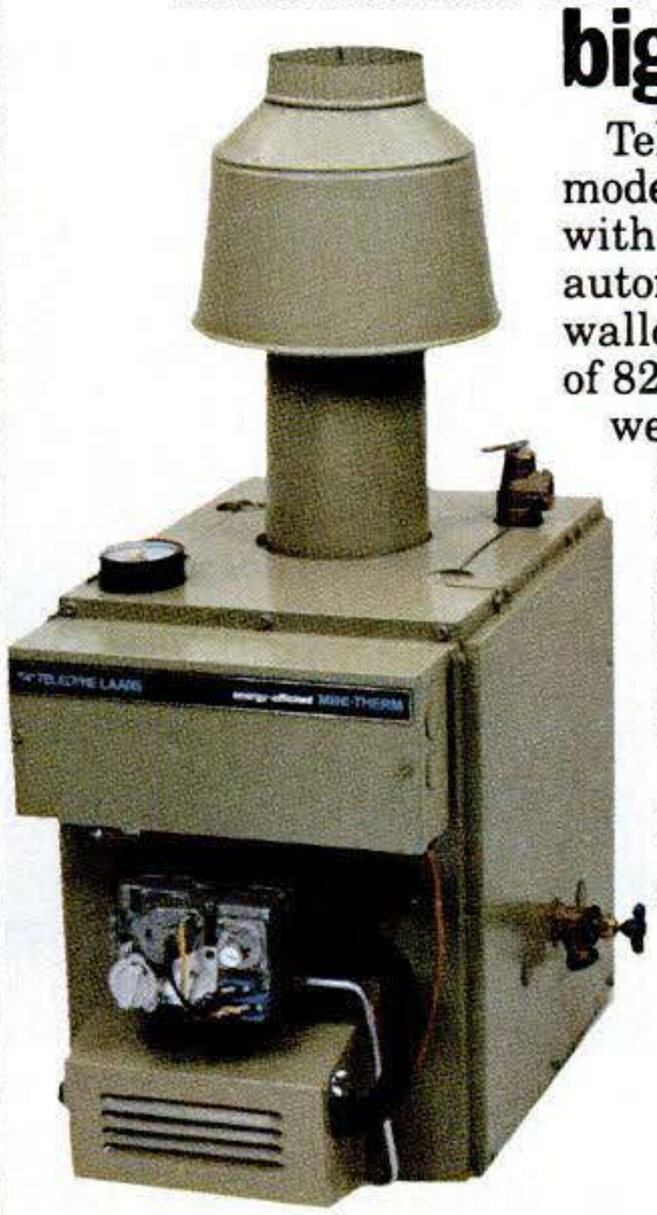
REVOLUTIONARY

Lennox Pulse™ gas furnace: A major advance in fuel savings.

Lennox introduces a breakthrough in heating technology called pulse combustion. It makes the Lennox Pulse™ the world's most efficient gas furnace. Fuel-use ratings run up to 74% higher than ordinary gas furnaces. The Lennox Pulse™ is a true gas saver and a true cost saver. It's the furnace for the future, available today. Call your Lennox dealer; he's in the Yellow Pages.

LITTLE GIANT

The MiniTherm gas boiler is a big energy saver.



Teledyne Laars' new MiniTherm model JVS 50 residential gas boiler with electronic pilot ignition and automatic vent damper packs a walloping D.O.E. efficiency rating of 82.4%. MiniTherm boilers weigh just over 100 pounds, fit anywhere. Combine a copper tube heat exchanger with two cast iron "wet walls" to outperform the giants of yesterday. Two ideal sizes: 50,000 and 75,000 Btu/hr. input.

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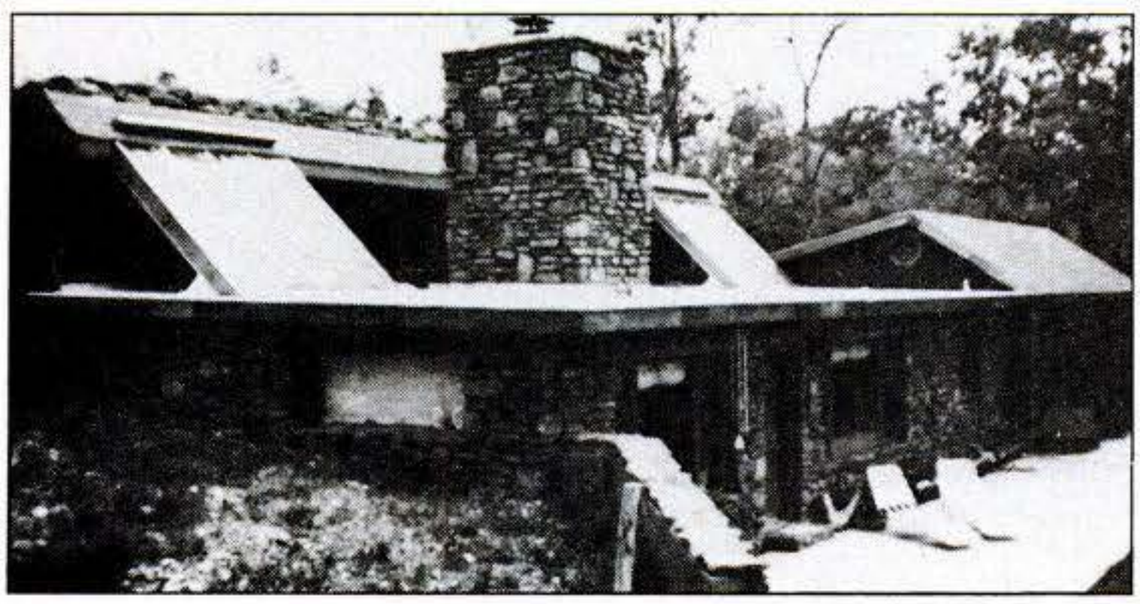
Underground envelope

is a natural heat pump

Ingenious hybrid offers the best of both solar and earth worlds

By TIM KLIEWER



Who says underground homes need little outside upkeep? That's author Kliewer behind upkeep machine. Structure should be isolated from outside, but retaining walls and stone chimney lack thermal breaks, bleed heat out.

I had already decided to go underground with the new home I was designing for my family in Siloam Springs, Ark., when I began hearing about a controversial new approach to energy-efficient housing. One of the first of these double-shell, or envelope, houses was critiqued in POPULAR SCIENCE [Dec. '79]: It was heated entirely passively by the flow of a surrounding envelope of air, which was driven by the temperature difference between a south-facing sunspace and a crawl-space heat sink.

There was considerable speculation as to how, or even if, this scheme really worked, but I was intrigued enough to adapt the idea to my new house. I reasoned that putting such an envelope underground would solve problems associated with both kinds of construction. The concrete roof of the house would put the heat sink in a more desirable location to power the loop, and the constantly moving air would reduce the humidity and mildew problems common in underground dwellings.

Whatever the final verdict on conventional envelope houses [PS will clear up some of the mystery in an upcoming issue], my design works well.

Heat is supplied to the loop by solar collectors using multiple layers of expanded metal lath placed diagonally within glazed, insulated redwood frames. Air rising through the units is heated to 120 degrees F on exit. During cloudy periods, heat to drive the loop is supplied by a wood stove.

Heat is withdrawn from the loop by a 10-inch-thick skin of concrete that forms the structure for the house. The key to the system is the way the concrete is insulated: Four inches of insulation board covers the roof; the upper part of the north wall has two inches; the middle part has one inch; and there is none below that or under the base. In combination with the variable temperature of the soil at corresponding depths, this pattern creates a temperature difference from top to bottom that is sufficient to cause con-

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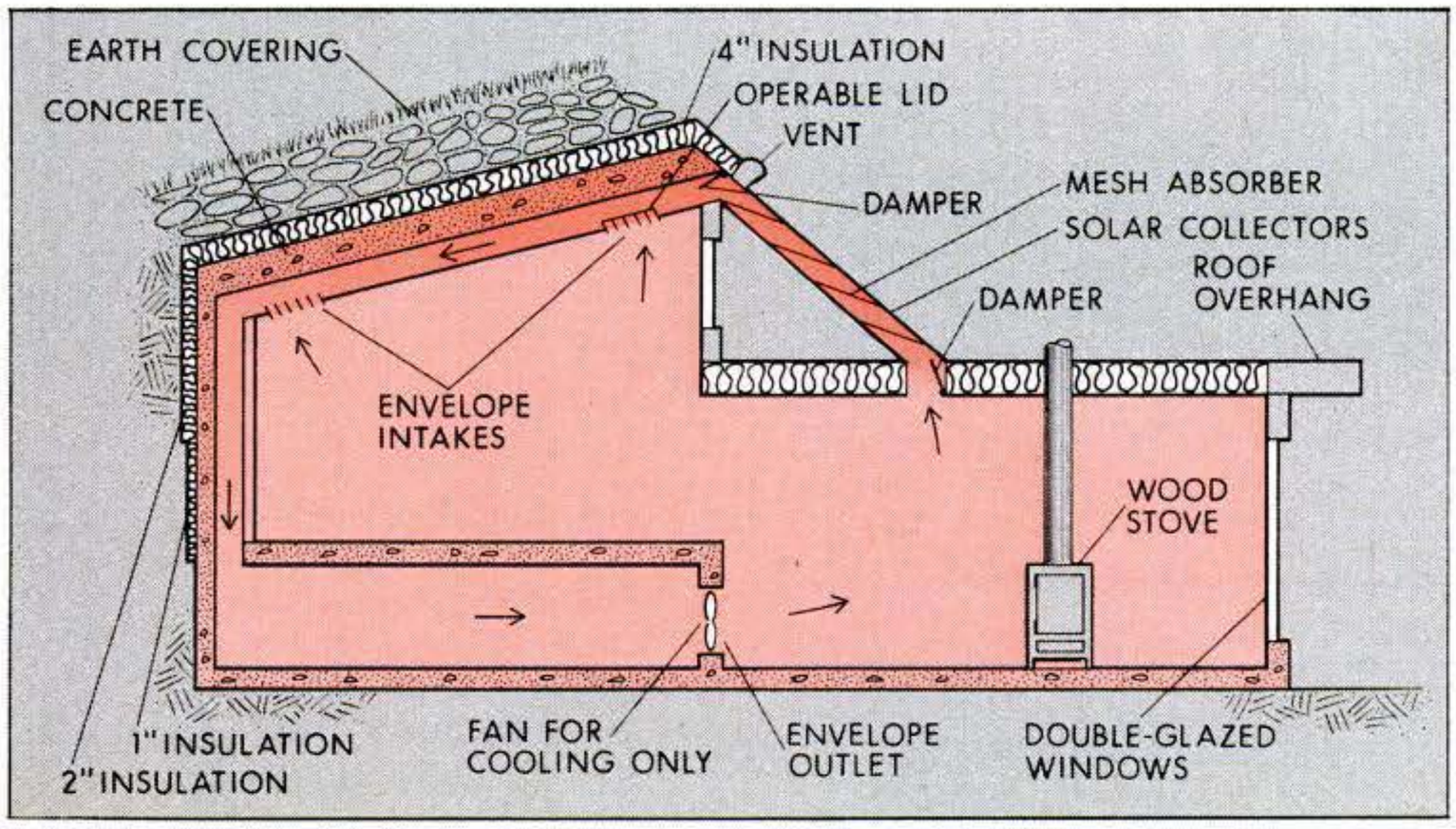

Variable insulation produces necessary temperature differential. When collector operates, concrete roof nearby reaches 85 deg. F, dropping gradually to 72 at concrete floor. Interior stays in low 70's.

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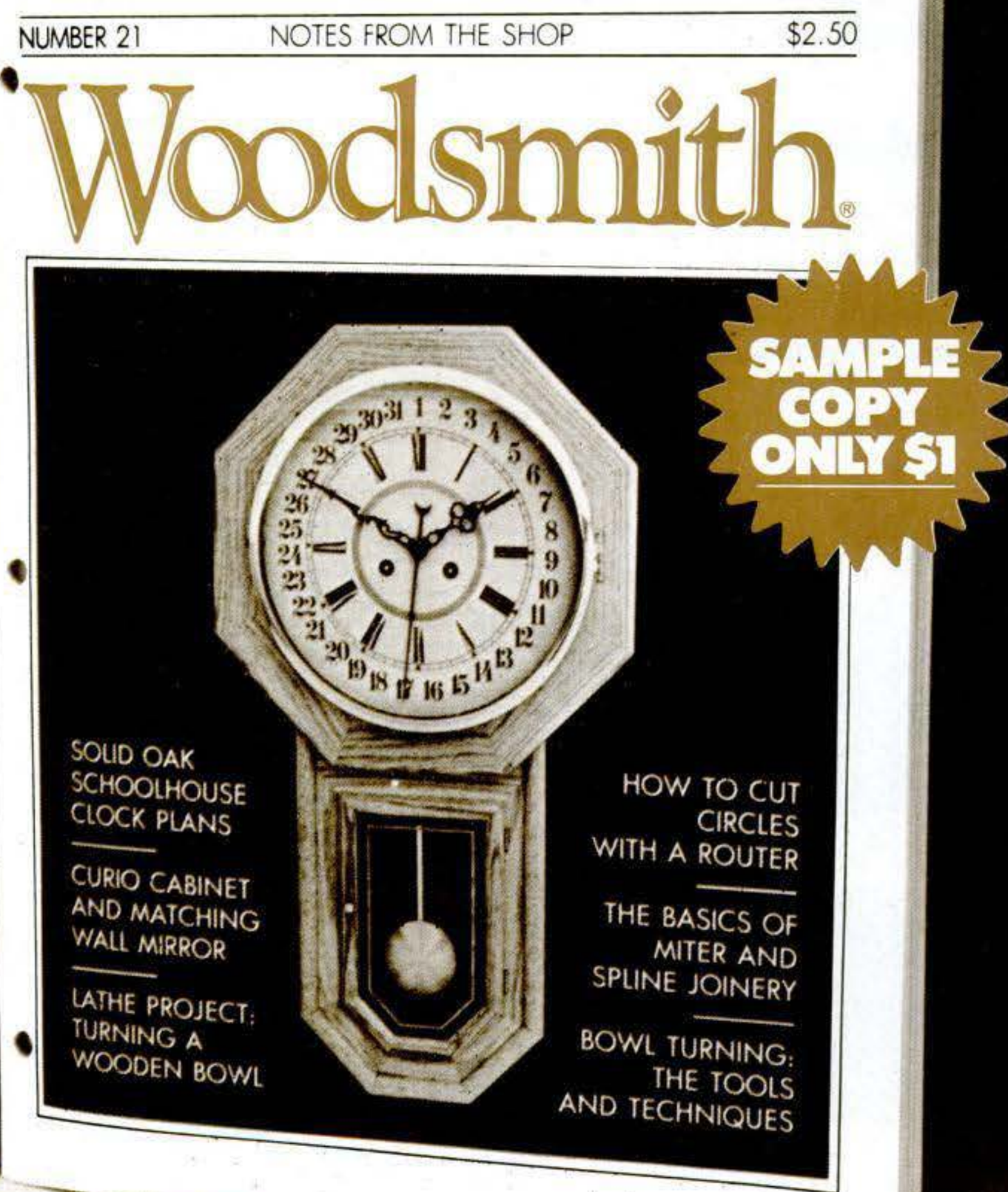
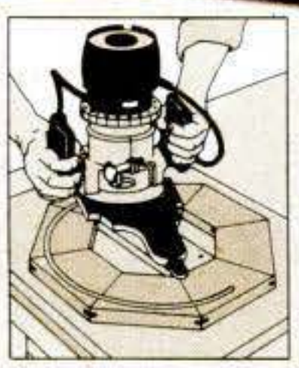
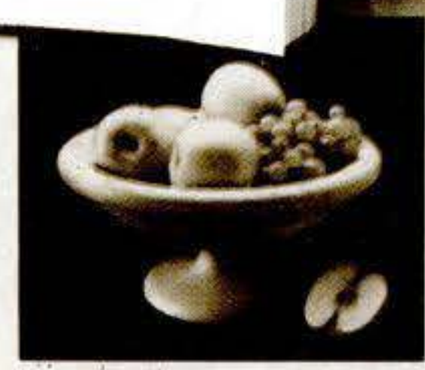
TIMELY OFFER



Spinning Server with How-to Drawings



Curio Cabinet


Turned Fruit Bowl

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Schoolhouse Clock. It's easy to build this solid-oak clock with the complete plans in this issue. All plans in *Woodsmith* include exploded views of the joinery, details of the problem areas, and down-to-earth directions.

Spinning Server. Discover how to cut perfect circles with the step-by-step illustrations for this Lazy Susan

Curio Cabinet. Miter and spline joinery is used to build the glass-paneled frames for this Curio cabinet. We've included a special article on a very accurate way to make this joint.

Bowl Turning. Five pages of step-by-step directions show you all the basics for turning this beautiful Fruit Bowl.

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Underground envelope

[*Continued*]

stant air circulation without fans or other power equipment.

A variety of controls, including vents, louvers, and transoms over doors, permits fine adjustments to be made to heat particular parts of the house. The main air loop runs from the collector outlets behind a dropped ceiling and frame wall to an underfloor flow space to deliver heated air to the lower part of the house (see drawing). Smoke tests have shown that during sunny periods, combined flow of the five envelope outlets totals 425 cubic feet per minute. Not bad for moving air without fans!

But not all that air makes the entire circuit. The downdraft in the envelope is intentionally greater than the updraft in the collectors, creating a venturi effect that continually draws room air into the envelope through egg-crate intakes in the upstairs bedrooms. The intakes in the loft part of the ceiling have operable lids that are opened when the wood stove is in use, giving a route for the backup heat to reach the thermal-mass ceiling. Wind chimes hanging in the loft area serve as a pleasant indication of wood-stove operation.

The envelope intakes toward the back of the bedrooms have no lids because circulation across the room is always desirable. Because of this inner air loop, if toast burns in the kitchen, the smell of smoke reaches the bedrooms, 40 feet away, sooner than at the adjacent dining table.

When neither the collectors nor the wood stove is operating, energy banked in the thermal mass is withdrawn. At those times, the direction of flow in the loop reverses, drawing cool air from downstairs and blowing heated air into the bedrooms.

In summer, the system works in a cooling mode. Since the air-flow space below the back floor level is uninsulated, it is kept cool by the soil temperature 10 to 15 feet below the surface. Nevertheless, the temperature difference between that space and the hot roof is insufficient to drive the convective loop entirely passively. Small window fans placed in the envelope outlets boost air movement to keep the house comfortable.

The author will answer readers' questions sent with a stamped return envelope to Energy Self-Sufficiency, Box 999, Siloam Springs, Ark. 72761. Detailed information is contained in his book, A Home for All Seasons, *available for $5. Complete blueprint sets are also available.*

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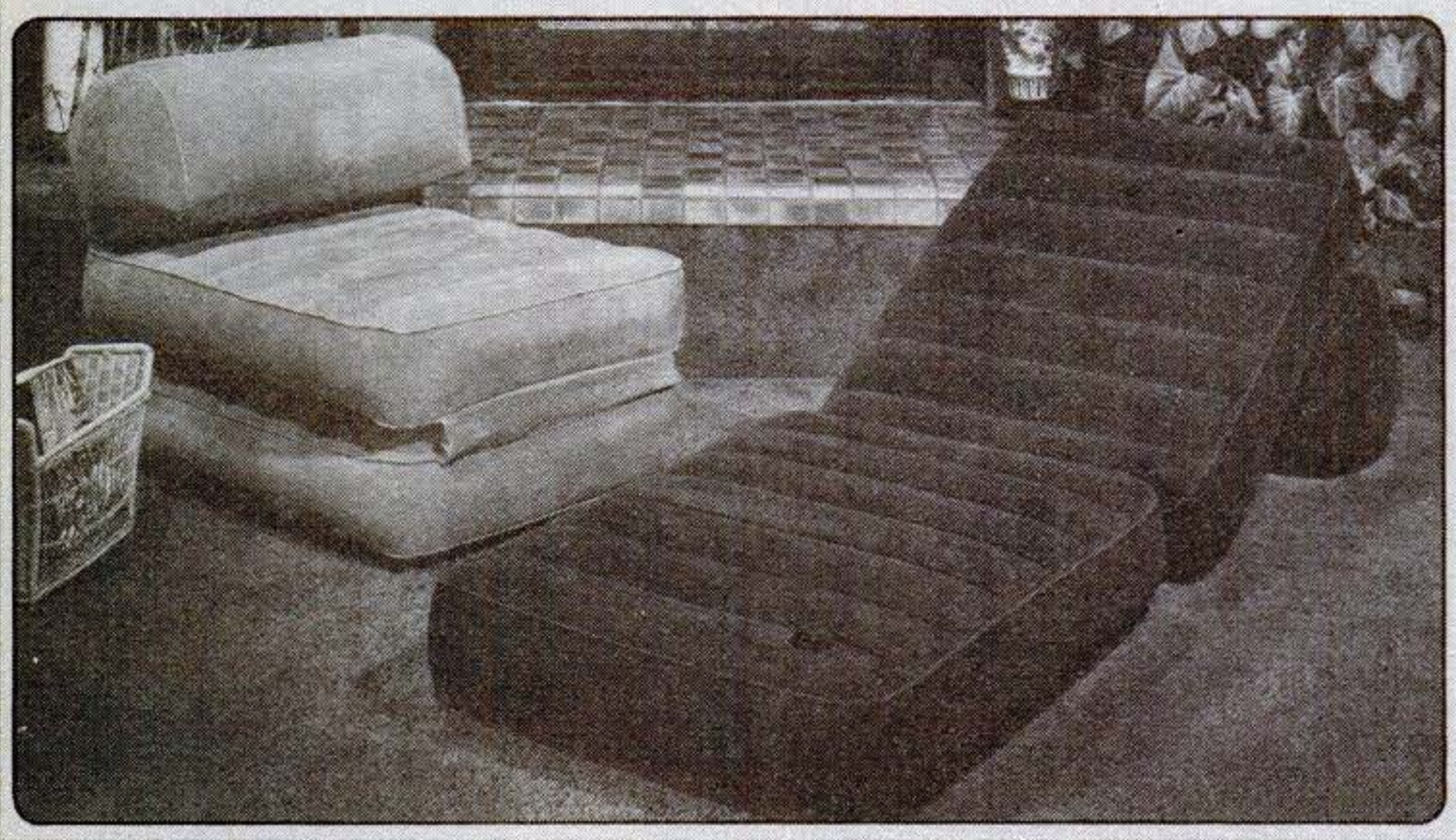

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AireChair's™ unique design features a *"series of air cushion coils"* providing solid support, yet giving perfectly with your weight distribution and contouring to the exact shape of your body—like no conventional furniture can. There's no resistance . . . only comfortable, all around, even support. Plus, there is no sinking down in the middle . . . it is genuinely like sitting or reclining on a full "cushion of air"!

The AireChair folds out from an attractive **contemporary chair** . . . to the ultimate TV or reading **lounger.**

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- A super **water raft** or **chaise lounge.**
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- 3 decorator color choices: Camel, Navy or Red
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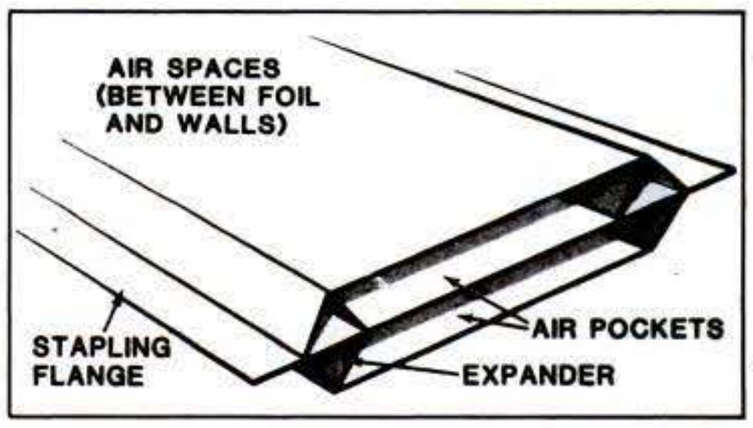
Aluminum shell insulates with air pockets



It was easy. I unfolded the R-19 foil insulation from its package, cut off an eight-foot length, popped it smartly to open the air pockets, then stapled it between the studs. In less than a minute I was ready to insulate the adjacent wall space.

The insulation, called Foilpleat, is a heat-reflective aluminum shell that creates four air spaces (see drawing) and delivers R-values of up to R-29. The pockets are created by bonding layers of paper-reinforced aluminum foil in a pattern that leaves space when the material is pulled taut. The insulation is made in two widths for installation between 16- and 24-in.-on-center studs.

Foilpleat is moisture-proof, meets all U.S. building codes, and has a class-one fire rating, says the maker (Foilpleat Insulation, Inc., 2020 W. 139 St., Gardena, Calif. 90249). It's also said to be 20 percent cheaper than fiberglass-batt insulation with the same R-value.—*Jim Schefter*

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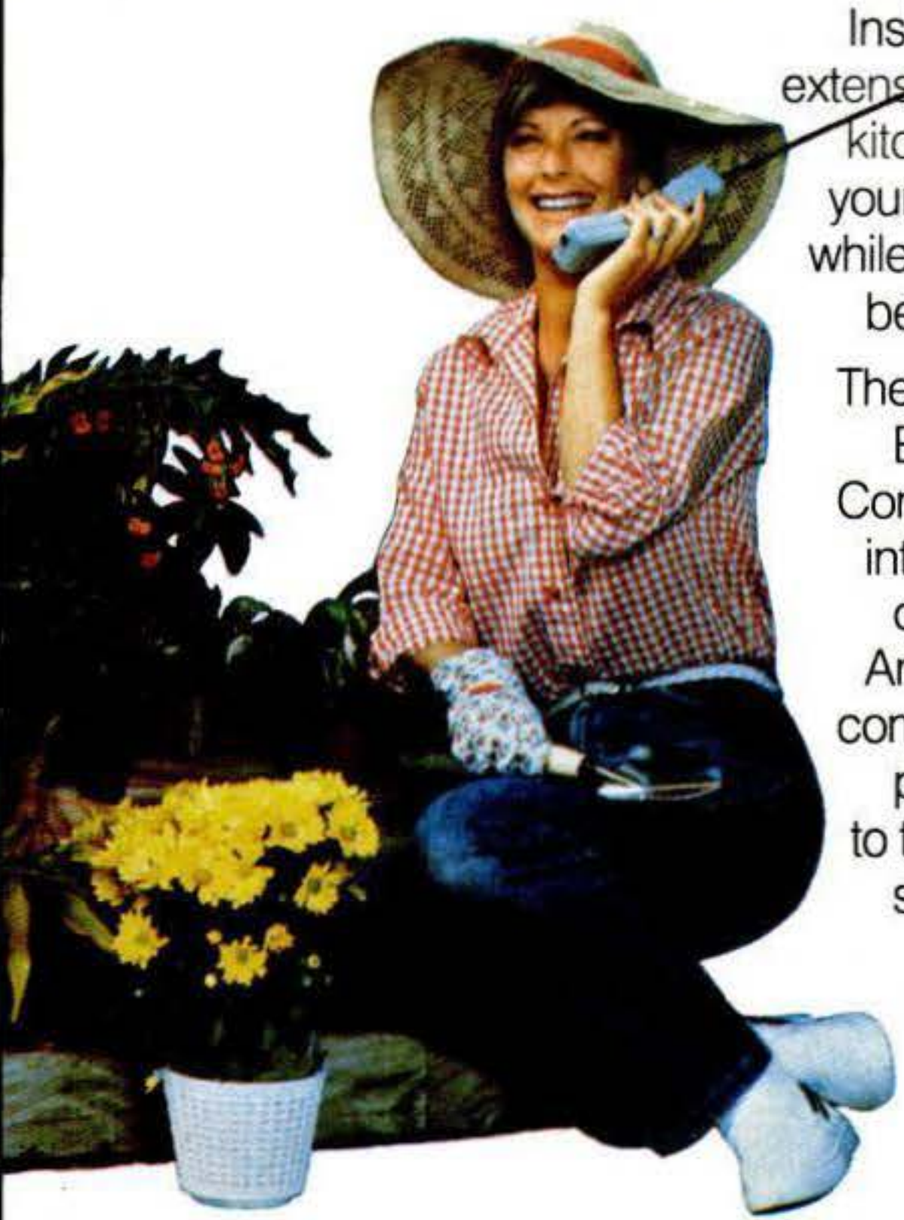
Cobraphone cordless phones follow you out to the sunshine

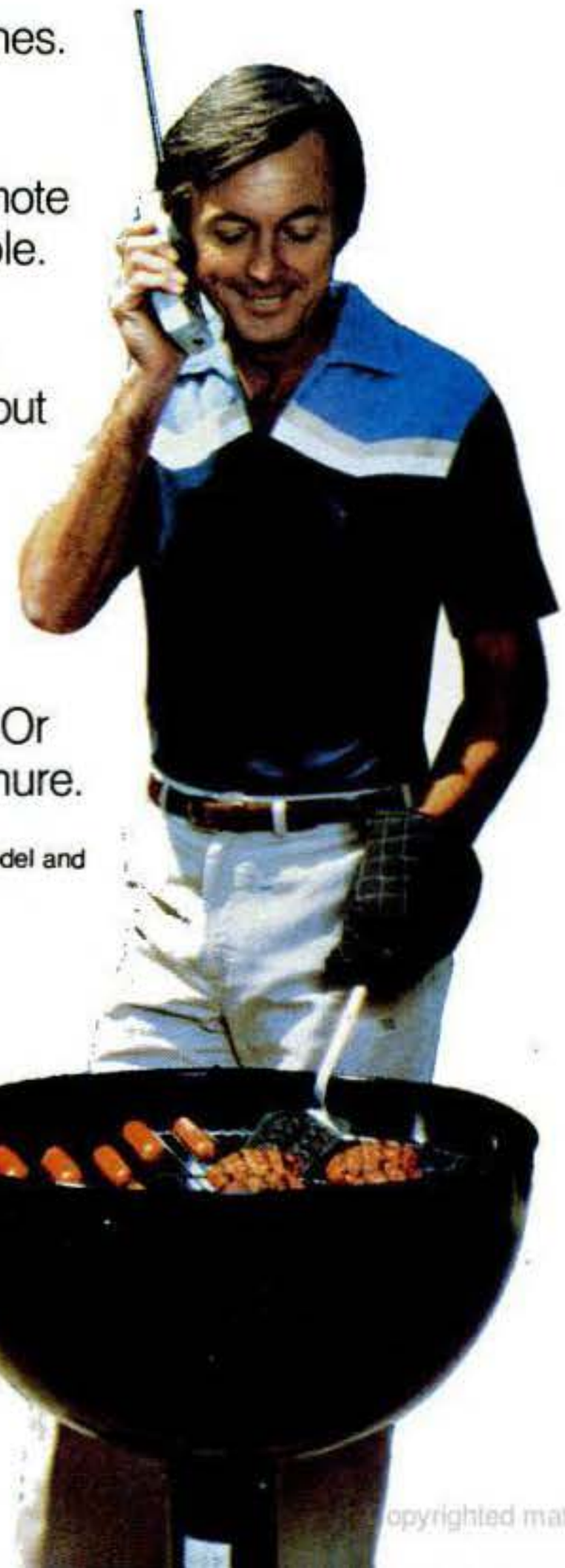
Wherever you happen to be, inside or around your home, your Cobraphone cordless phone goes where you go. *Because there's no cord to tie you down.* Whether you're relaxing on your patio, tinkering in the garage, mowing the lawn, or across the street at a neighbor, you'll never miss a call with the phone that goes outside with you. It makes and receives calls to or from anywhere in the world, like any phone. Operates up to 600' from the base unit.* That's the length of two football fields.



Inside it's a completely portable extension phone. Use it in the kitchen without stopping your chores. Take a call while you're in the bathtub and the caller will scarcely believe it. Keep it at your side when watching TV.

There's a wide choice of Cobraphone cordless phones. Even a combination cordless phone/clock-radio. Computer memory for automatic dialing, 2-way intercom, automatic redial of busy numbers and remote charging are a few of the exciting features available. And because it's *your* phone – not the phone company's – there are no monthly lease charges to pay. Enjoy the luxury of the phone that follows you out to the sunshine. Sets up by just plugging the small base unit into an ordinary phone jack and AC outlet. FCC approved. See Cobraphones at catalog showrooms, department stores, telephone and electronic specialty stores. Or write for free descriptive brochure.

*Range from base unit varies with model and local conditions.



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TOUGH V8 DIESEL POWE

America's best-selling truck diesel is now available in tough Chevy Vans and Sportvans. Now you can get available 6.2 Liter (379 Cu. In.) V8 Diesel power in 1983 G20/30 Series Chevy Vans and Sportvans. It's already in service in over 100,000 full-size 1982 Chevy Pickups, 4WD Blazers, Suburbans and Step-Vans. That kind of acceptance says a lot about the performance and desirability of this diesel power. The 6.2 Liter Diesel in a G20 Chevy Van offers you up to 24% better fuel efficiency than a 5.0 Liter (305 Cu. In.) 4-Bbl. V8 gas engine in the same vehicle. And the 6.2 Liter Diesel provides up to 33% better fuel efficiency than this gas engine in a G20 Sportvan. Consider these impressive mileage figures.

30 EST. HWY. **20** EPA EST. MPG * G20 SPORTVAN WITH OPTIONAL 6.2L DIESEL AND AUTOMATIC OVERDRIVE

31 EST. HWY. **21** EPA EST. MPG * G20 CHEVY VAN WITH OPTIONAL 6.2L DIESEL AND AUTOMATIC OVERDRIVE

Chevy's G30 Diesel Van. The Chevy Van advantage goes way beyond diesel power. The available 6.2 Liter Diesel G30 Chevy Van is rated at 240 lbs.-ft. of torque at 2000 RPM. So Chevy Van digs in and hauls hard under full loads (up to 3682 lbs., including passengers, equipment and

125" WB Diesel Chevy Van.

TOUGH CHEVY TRUCKS ARE

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TIME EVER

m STANDARD-SIZE VANS.

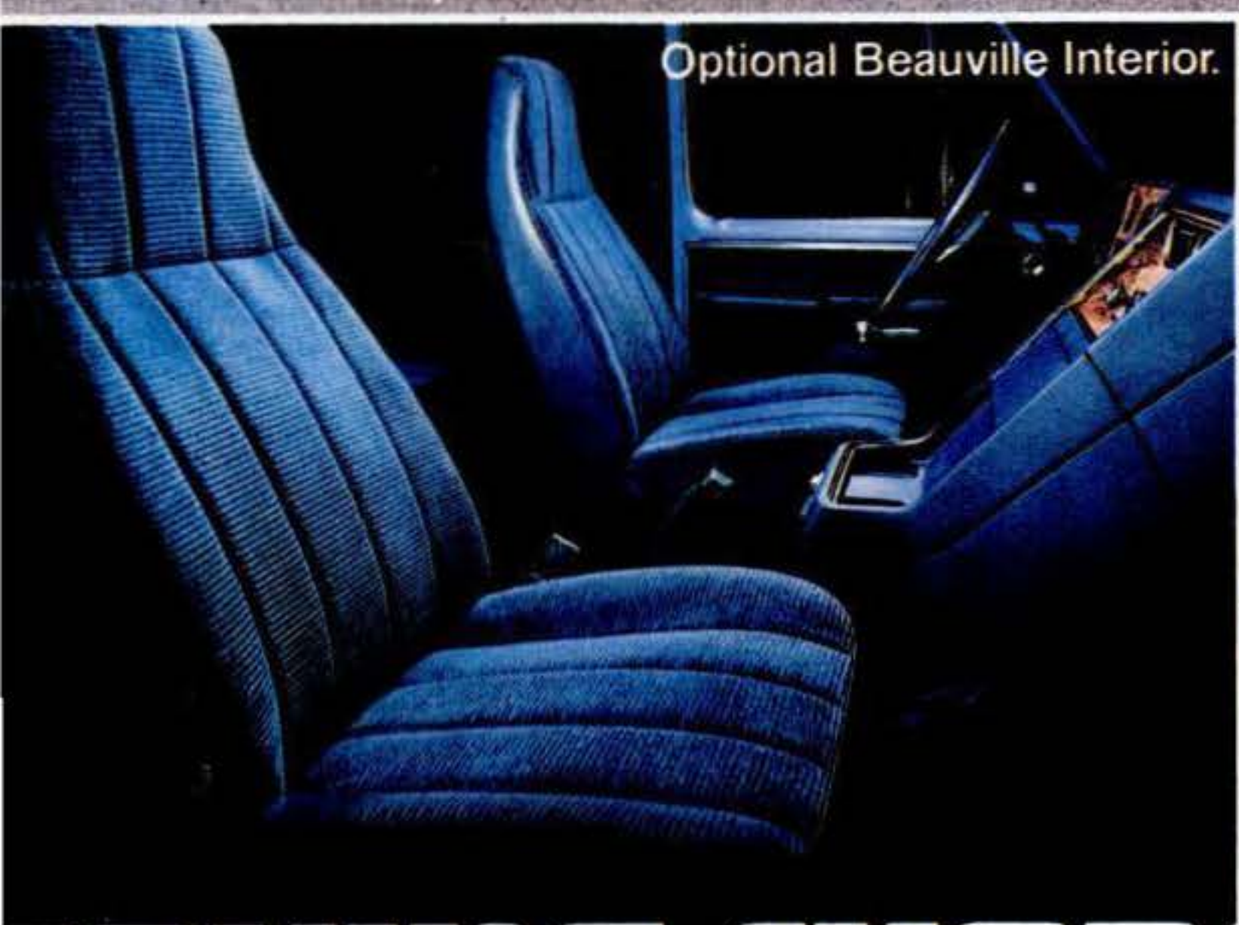
cargo, in a properly equipped model). All long-wheelbase models have a big 296 cu. ft. of load space—and load length for a 14-foot ladder! What's more, a properly equipped G30 Chevy Van can move up to 12,000 pounds, including itself, passengers, equipment, cargo and trailer.

Chevy's Diesel Sportvan. Here's how Chevy moves people with style, comfort and convenience. There's standard seating for five, but the G20 Sportvan offers optional seating for eight and the G30 model offers optional seating for eight or twelve. In addition, quick-release rear bench seats help convert Sportvan from people-carrying to cargo-carrying in a hurry.

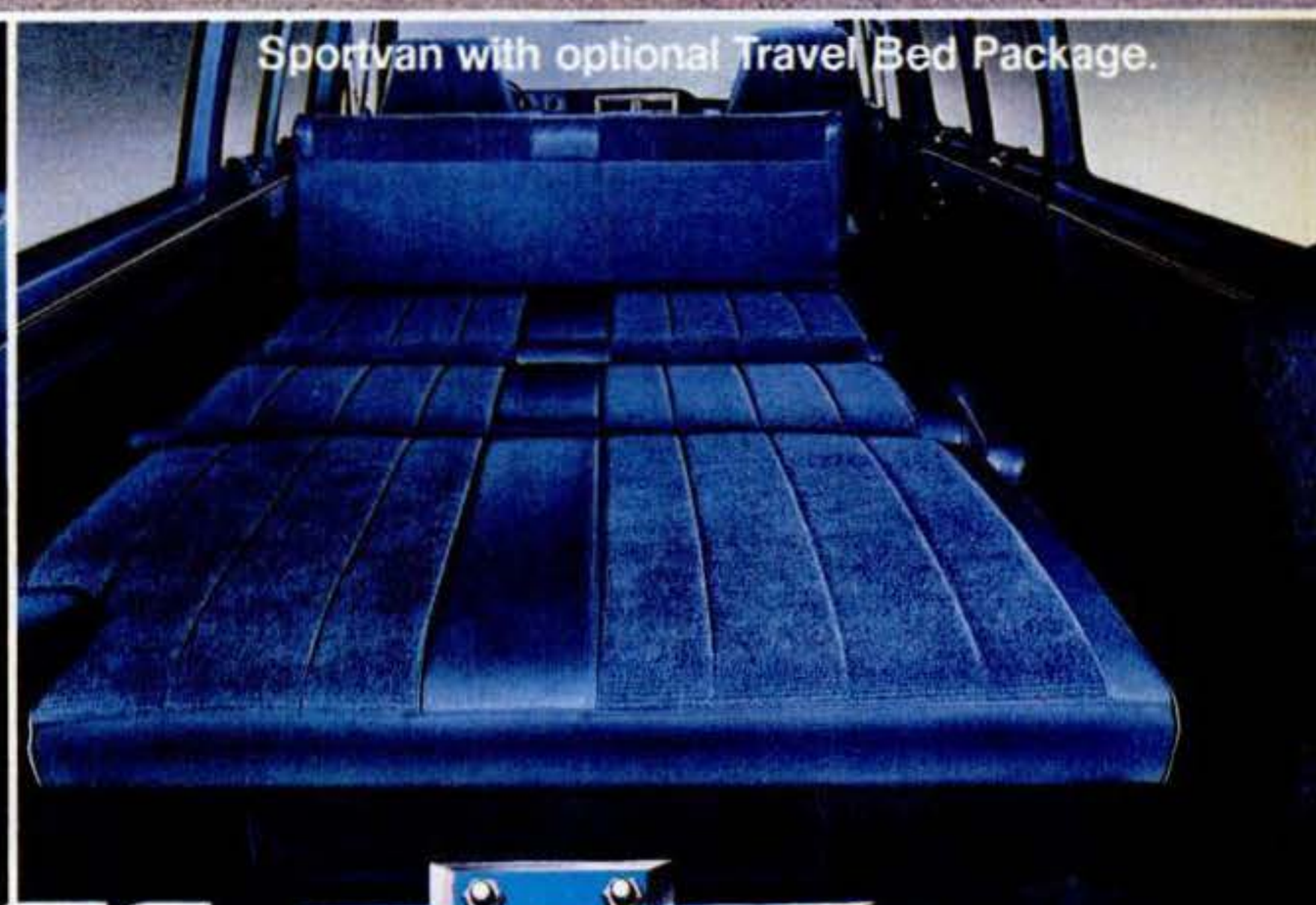
3-Year/50,000-Mile Power-Protection-Plus Limited Warranty on Diesel Engines. Subject to deductible after first 12 months/12,000 miles. See your Chevy dealer for full details.

*Use estimated MPG for comparisons. Your mileage may differ depending on speed, distance, weather. Actual highway mileage lower. In Calif., Chevy Van 30 Est. Hwy., 20 EPA Est. MPG. Some Chevrolet trucks are equipped with engines produced by other GM divisions, subsidiaries, or affiliated companies worldwide. See your dealer for details.

125" WB Diesel Sportvan.



Optional Beauville Interior.



Sportvan with optional Travel Bed Package.

TAKING CHARGE

CHEVROLET

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Plastic bike
loaded with innovations

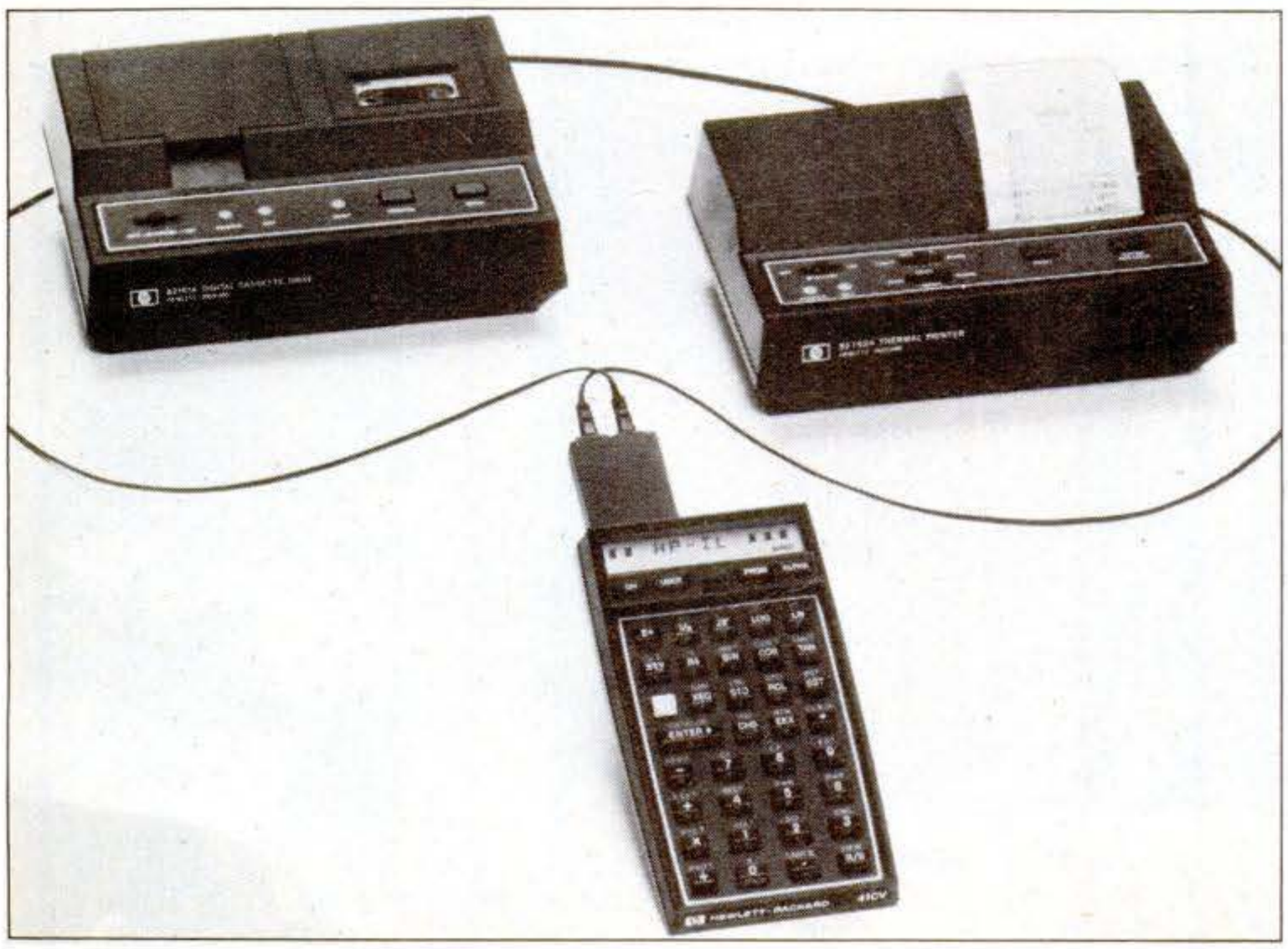
Exotic new materials have stimulated major design changes in automobiles, aircraft, and other high-technology products, but the lowly bicycle has seen few benefits from space-age developments. Now a Swedish company has substituted glass- and carbon-fiber-reinforced injection moldings for the standard steel for most of the main parts of its new bike, the Itera. Its composite components include the frame, wheels, front fork, crank arms, sprockets, and luggage carrier. Result: elimination of much time-consuming, labor-intensive metalwork and assembly.

The 29-pound machine requires a fifth the amount of energy for production (compared with a standard bike), needs little maintenance, and is packed with bright ideas: battery and wiring for front and rear lights housed inside the frame for protection and neatness; a built-in locking system; and a rain cape that reels out of a compartment behind the saddle.

The Itera now uses standard gearing systems—ranging from one to 12 speeds—but an automatic continuously variable transmission is under development. Servo disc brakes and a plastic chain are also promised.

The Swedish maker (Itera AB, Gothenburg) is currently negotiating with firms in Scandinavia, Britain, Japan, and the U.S. for local manufacture of the bike. The company expects the bike to be available to American cyclists by year's end for about $200.—*David Scott*

Interface loop
links test gear



You've just built a piece of electronic gear, and now you're going to test it: a voltage reading here every 10 minutes, a current readout over there every 20 minutes, and a resistance check every half-hour. Normally, that requires human skills—or those of an elaborate computerized test setup. Now you can use a pocket calculator.

It's called the HP-IL system, for Hewlett-Packard Interface Loop. It means that new components from HP will work together by just plugging them in. The HP-41 programmable can act as the intelligent controller: It receives instructions from a remote tape drive, performs the tests with a programmable digital voltmeter, and records the results on a printer.

Up to 961 devices can be linked by cable, each up to 100 meters apart. Add or subtract gear at any time—the controller polls the system and knows what's connected before any instructions are sent. Data is transferred at 5,000 bytes per second.

Besides HP products designed to use the loop, an RS-232 adapter will be available for connecting equipment from other manufacturers. For that, you'll need more information from HP (1820 Embarcadero Rd., Palo Alto, Calif. 94303).—*W. J. Hawkins*

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This new computer from Timex represents a major breakthrough: a real computer at an almost unreal price. What makes it possible are our advances in microchip technology and computer circuitry. And, as technology increases, price decreases. It happened to the calculator. It happened to the digital watch. Now Timex has made it happen to the computer.

The Timex Sinclair 1000™ allows you to use your own TV as a display monitor, and your audio cassette recorder for storing programs. For $99.95* you get everything else you need, including our step-by-step learning guide that'll have you running programs within hours. And writing them within weeks.

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TIMEX COMPUTERS

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There's only one way to play it...

Kings, 2 mg. "tar", 0.3 mg. nicotine; 100's, 5 mg. "tar", 0.6 mg. nicotine av. per cigarette by FTC method.

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

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Heating-cooling controller

seeks best settings

Computer control runs off the 25-volt thermostat transformer and is wired between the thermostat and the fan, heater, and air-conditioner controls.

Hook up your heating and cooling systems to the Home Energy Manager and it will reduce the energy needed to make your home comfortable. A microprocessor continuously adjusts the on-off times of your furnace or air conditioner, searching for the best combination. The object: to run energy-consuming devices for the shortest possible time needed to keep temperatures at the level you've set.

The microprocessor module does not replace the thermostat. Instead, it's wired in series so it can monitor just what the thermostat does during each 15-minute cycle. If the thermostat demands heat, for example, and the burner runs five minutes to satisfy the demand, the Energy Manager will let the burner run only four minutes the next time. The computer will also run the fan or circulator a few extra minutes.

If the combination satisfies the thermostat, the computer will try running the burner only three minutes during the next cycle. If that is not enough heating time, the computer returns to four minutes.

In summer, the system regulates the air conditioner in the same way. A separate circuit controls the water heater.

The Energy Manager provides a minimum of 96 test-setting combinations during each 24-hour period, according to the manufacturer (Power Management Systems, 7094 Peachtree Industrial Blvd., Norcross, Ga. 30071). The $599 system can produce energy savings of 35 percent, the maker claims.—*Erik H. Arctander*

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See-through
sun plotter

Unanticipated shading of a solar collector or even a slight shadow across an add-on sunspace can defeat the whole purpose of erecting a solar improvement. Site evaluation—which includes spotting those problems—is the most important part of planning for solar projects [PS, Feb. '82], yet often it's given little attention—except when it's too late.

Site evaluation can be simplified with a Solar Card. This see-through sun plotter ($12.95 from Design Works, Inc., P.O. Box 489, North Amherst, Mass. 01059) enables you to see potential obstructions of the sun throughout the year.

The Solar Card is an eight-by-10-in. piece of transparent acrylic with the path of the sun during each month drawn on its face. Facing south and looking through the card shows any objects (viewed through a grid) likely to block the sun during the year.

You can use the card, too, to figure the percentage of shading on a site during any period of the year. You count the number of boxes enclosed by lines of the grid that are either fully or partially shaded and divide by the total number of boxes (36). This gives you a percentage that represents the annual shading. A figure of 20 percent (about the maximum tolerable shading) means that one-fifth of the area is in shade during the most critical hours, 9 a.m. to 3 p.m.

Solar Card can be used for different latitudes of the country (specify yours when ordering).—*Charles A. Miller*

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No other ultra brings you a sensation this refreshing. Even at 2 mg., Kool Ultra has taste that outplays them all.

Kings, 2 mg. "tar", 0.3 mg. nicotine; 100's, 5 mg. "tar", 0.6 mg. nicotine av. per cigarette by FTC method.

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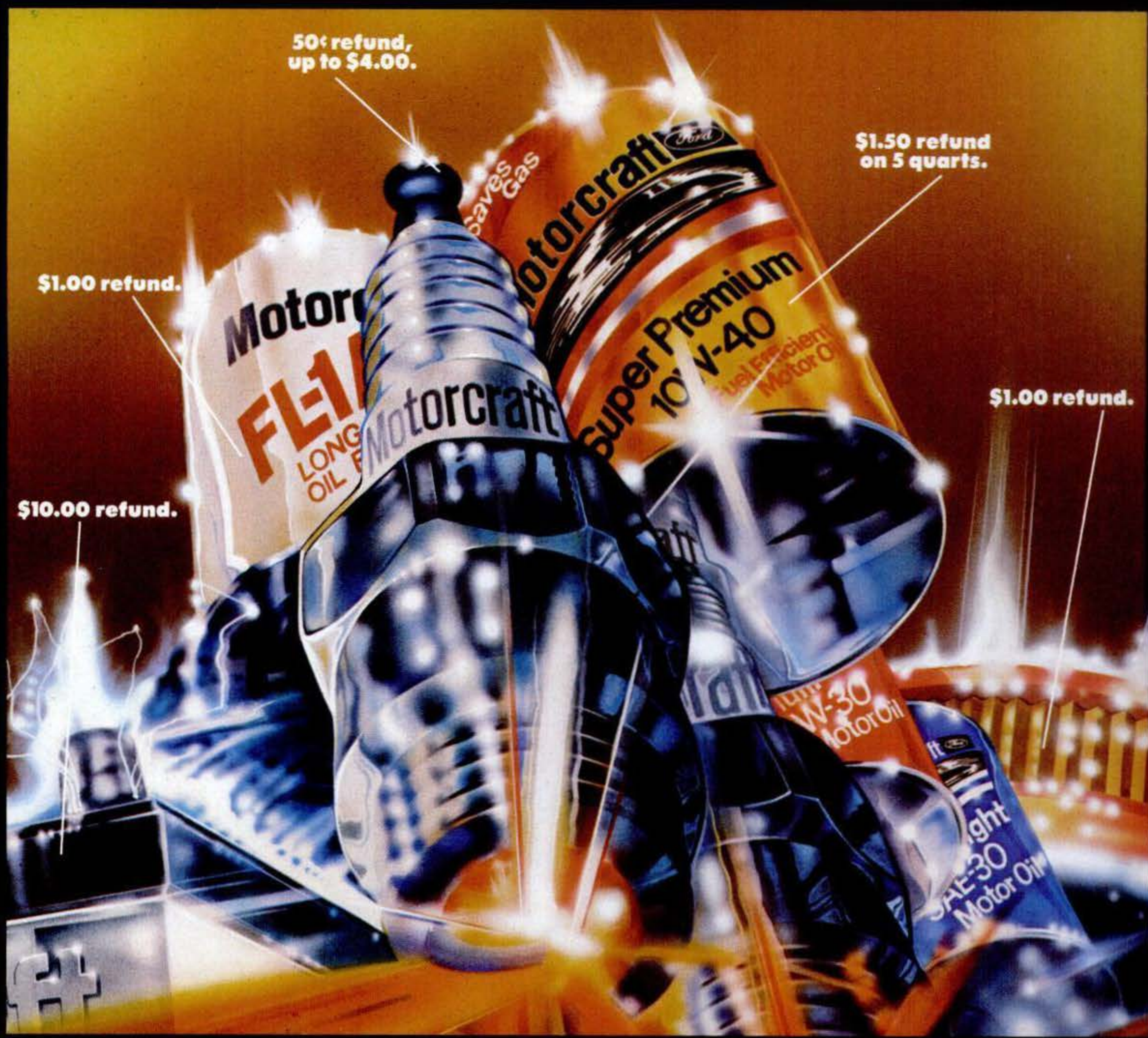

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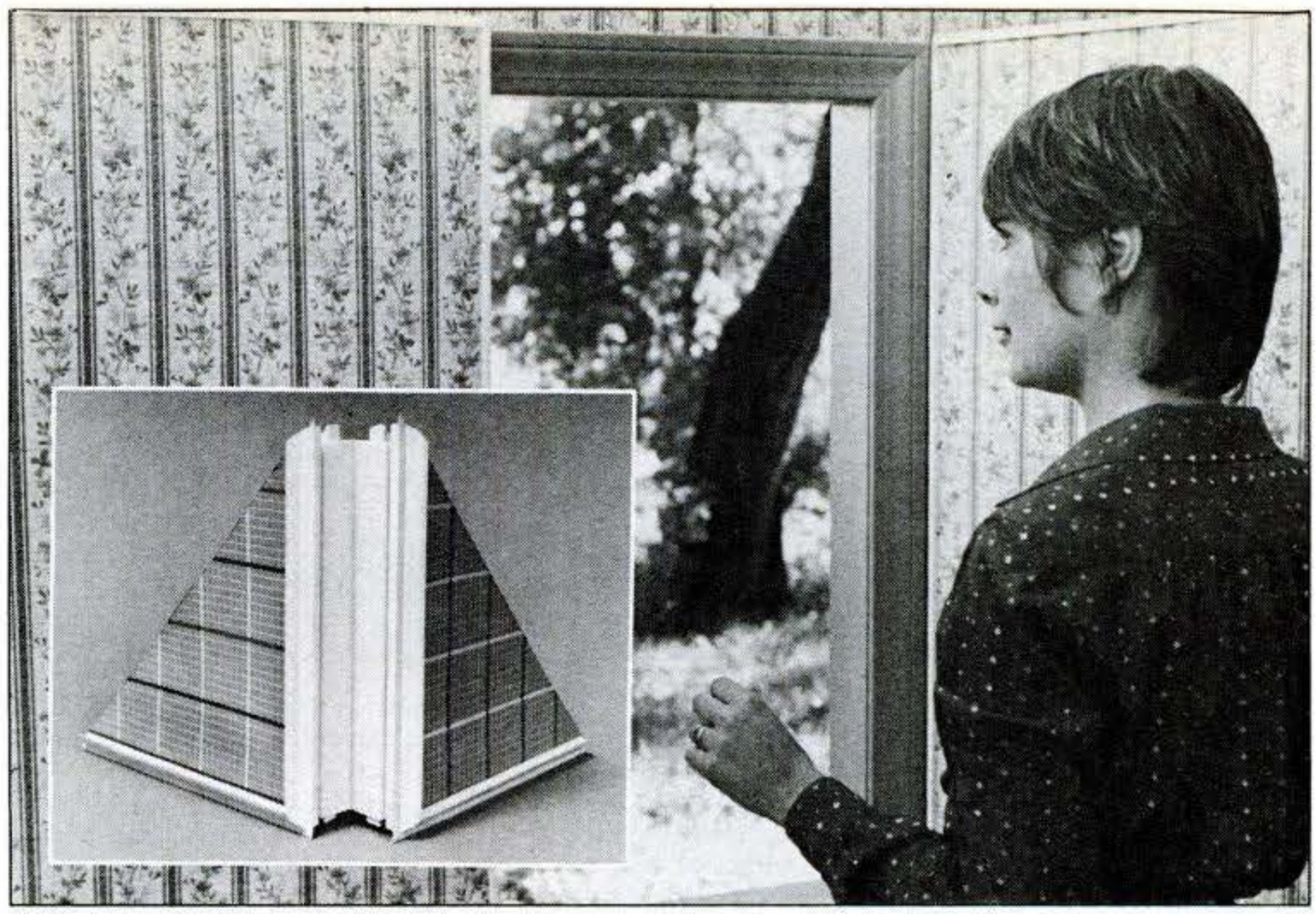
Cut-to-fit thermal shutters



Glass. Come winter, it's truly a fair-weather friend: In sunshine, it's a welcome source of heat and light. But in the evening, it's capable of stealing up to 20 percent of your heating energy. Double and triple glazing help enormously, but now you can do more.

Thermal Wall is a shutter—a thermal barrier you close over glass doors, windows, or even skylights to cut heat loss by as much as 90 percent. But best of all, you can make this shutter yourself—using a new kit of hinge and framing hardware from Solar Systems Design.

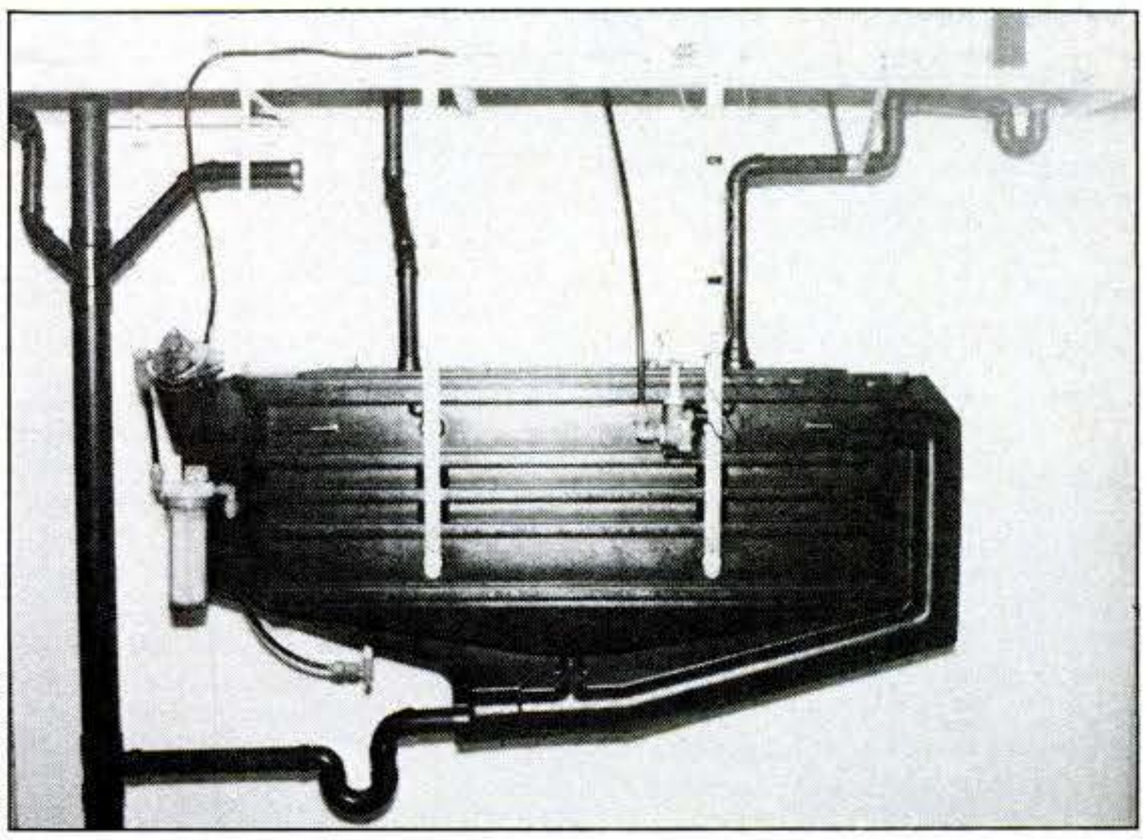
The framing is made of PVC and contains its own weatherstripping for an airtight seal. It comes in seven-foot lengths you cut to fit.

The insulating material does not come with the kit, but you can use any rigid one-inch-thick panel such as Styrofoam, Thermax, or phenolic foam (available at most building-supply stores). Before installing the panel, it can be decorated to match the interior of the room. Use anything: paint, wallpaper, even a fabric. Once covered, the panel slides into the tracks of the frame and the frame is attached to the wall using special polypropylene hinges. (With optional hardware, panels can be combined into a bi-fold shutter system.)

There's an alternative to covering the insulating panel. The frame contains a second set of tracks for a "cover" panel. This can be any rigid 0.2-in. stock, such as a sheet of hardboard. It can be left plain or covered, as well.

Cost of the framing material is about $1.50 per foot. It's available from Solar Systems Design, RD#1, Box 426A, Voorheesville, N.Y. 12186.—*W. J. Hawkins*

Water recycler
flushes toilet



Gray water enters top of plastic tank from the vertical pipe to right of center; vertical pipe on left is a vent. Small cylinder on left side of tank is the filter; pump is directly above.

About 40 percent of your household water goes down the toilet, according to six authoritative surveys. In a four-person family, that's probably more than 100 gallons a day—a considerable matter of concern if you depend on a well or live in a dry area.

The Water Maide Recycler saves most of that 40 percent by collecting "gray" water from showers, tubs, sinks, and washing machines, then flushing the toilet with it.

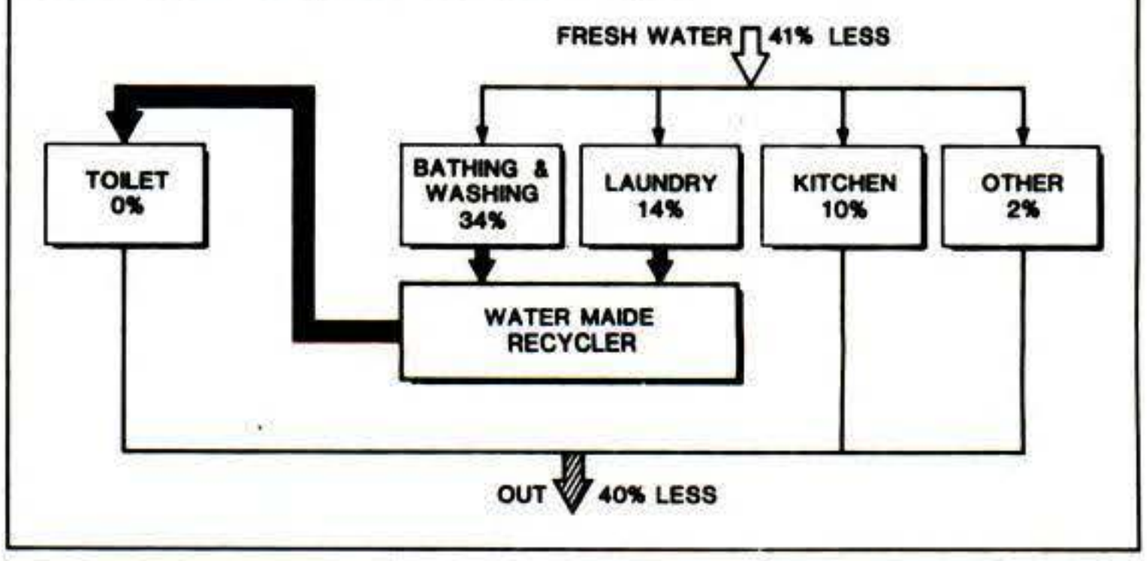
The gray water runs into a 60-gal. ABS plastic tank hung from joists in the basement. There it's treated with a defoaming, deodorizing agent that turns it blue so you can tell if the system is working.

When you flush the toilet, pressure drops in the supply line, activating a pressure switch on Water Maide's pump. The pump fills the toilet tank with treated gray water until signaled to stop by the closing of the tank valve.

If the gray-water tank gets too full, the excess runs out an overflow pipe. If it runs dry, a float-operated valve lets in fresh water for one full flush at a time.

The tank, 77 in. long by 16 in. wide and 41 in. deep, weighs about 600 lbs. full. It comes with four perforated steel straps for bolting to floor joists. The Burning Log (Airport Business Center, Box 8519, Aspen, Colo. 81611) lists the Water Maide for $1,350.—*Erik H. Arctander*

How the recycler saves water



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Shelter Your Car

Protect your car at home and work, rain or shine; but beware, *all car covers are not the same...*

Prevent *"PREMATURE DEPRECIATION"* from Unnecessary Exposure to the Elements, with a Custom-fitted STARSHINE AUTO SHELTER*!

Complete exterior and interior protection—in less than 1 minute! Starshine Auto Shelter's™ improved and superior new fabric totally shields your vehicle from nature's single most damaging element... the SUN. Direct exposure will oxidize your paint, bake dirt and grime into the finish and fade the color. Plus, ultraviolet rays magnified by the windshield glass will cause your car's dashboard and other interior upholstery to crack, split, and fade as well. A Starshine Auto Shelter™ will prevent all of these value-robbing losses from occurring. If used regularly, your Auto Shelter™ will keep your car looking new, inside and out, for years to come, plus keep it cleaner, even when parked in your garage.

Starshine Auto Shelter*...a revolutionary breakthrough in protective car cover fabrics. It is a remarkably improved blend of space-age textiles and natural fibers custom designed and manufactured to fit *and thoroughly shield* every automobile, truck, van or cycle — foreign or domestic. Each cover is individually tailored to fit your make of car as opposed to lesser quality, bulky "universal" type cover-alls. Auto Shelter's* tight fit insures complete protection against high winds, and snow or rain will not get trapped underneath.

Water-resistant — not waterproof. Here's why: A "waterproof" cover traps moisture under the cover. This vaporized water can cause clouding of paint when the temperature is raised (from hot sunlight) and air circulation is eliminated by the cover. A beautiful finish can be ruined in a matter of hours. Taking this important factor into account, Starshine Auto Shelters* are purposely made to be effectively water and mildew resistant — a smart balance between potentially damaging "waterproof" covers and flimsy 100% cotton covers that quickly absorb most liquids, offering minimal protection. Starshine Auto Shelters* are also fully washable and wrinkle resistant.

In addition to eliminating unattractive oxidation and fading, your Auto Shelter* will protect your vehicle from the harmful effects of smog, industrial pollutants, sea and road salt, dust, sand, rain, snow, ice, sleet, tree sap, bird droppings, tar, etc. With the higher cost of new autos today it makes sense to protect your investment from these harmful elements.

■ No snow or ice-scraping this winter ■ Clean windows stay that way ■ Reduced chances of engine freeze-ups and dead batteries ■ Reduced maintenance, washing, painting, etc. ■ Minimized threat of vandalism and theft ■ Protection for your exterior shine, your interior upholstery, and your financial investment. ■ Free storage bag included ■ Special 2 Year Limited Warranty against tearing, fraying or losing its shape or water repellency! *Trademark

$59.95 for these cars (Code #106, w/lock #107)

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Hand-held terminal
links you to computers

"Hi, Jim . . . Password?"

That message, scrolling across a 16-character liquid-crystal display line, was my entry into the new world of hand-held computer terminals. I had just turned on an IXO Telecomputer (Culver City, Calif.), a 15-ounce unit not much larger than many calculators.

The difference was that this little terminal, plugged directly into the telephone line, was about to connect me to a remote computer data base. I keyed in a previously selected password, and the display instantly began a plain-English dialogue. I tapped a button marked NO each time the terminal displayed various data-bank services ["Info Banks," PS, Nov. '80]. When CompuServe appeared I pushed a YES button. The IXO terminal flashed its phone number, automatically dialed it, and went through the steps needed to log onto the service. CompuServe provides stock-market quotes, stories from newspapers and POPULAR SCIENCE, electronic mail, and more.

"We want to do for data what the telephone has done for voice," says Jeffrey Rochlis, IXO president. The hand-held IXO terminal was introduced in mid-spring, selling for about $500. Designed for use by novice or expert, it has built-in security, automatic features, and can be mastered in minutes. Its one-line display is adequate, but no more.

For now, the terminal is intended for commercial users and data-base subscribers. A sales representative can patch into the firm's computer to check inventories and transmit orders. Banks are evaluating it for personal banking applications.

A printer option and video interface for any TV set are nice since they provide larger readouts. —*Jim Schefter*

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PEST-PRUFE™ is small and unobtrusive--rugged, hi-impact case has black finish with brushed silver face. Measures only 3-1/2"x4"x3-1/2". Weighs about a pound.

Clear Your Home of Mice, Rats, Roaches and Other Pests--and Keep Them Out!

PEST-PRUFE™ is a home-size version of the commercial pest control device that's safe for people, pets and the ecology. Try it in your home for 30 days.

They don't call them pests for nothing. The bugs and rodents of this world can make life miserable. Traps, sprays and poisons seem to have little effect . . . and professional exterminators don't come cheap. But now you can eliminate troublesome pests and keep them out thanks to new utltrasonic PEST-PRUFE.

The electronic PEST-PRUFE unit doesn't kill rodents or insects—it repels them. Early laboratory research showed that ultrasound was effective in modifying the behavior of mice and rats.

As commercial exterminators began using ultrasonic sound to control rodents, other studies indicated that certain frequencies affected the behavior of insects, too. Now, professional pest control companies acknowledge the usefulness of ultrasonics in controlling certain rodents and insects.

UNIVERSITY TESTED

The heart of this new, electronic marvel is a special quartz crystal speaker. It enables PEST-PRUFE to emit ultrasonic sounds that only pests can hear.

These ultrasonic frequencies "attack" the auditory and nervous systems of rodents and certain insects causing pain and discomfort. The pests are forced to abandon the covered area and will not return while you continue to use PEST-PRUFE.

A leading university tested PEST-PRUFE as absolutely safe for humans and pets. And since there are no poisonous chemicals, the ecology is not harmed in the slightest.

The ultrasonic output is above the hearing range of humans and household pets, so PEST-PRUFE is safe for use anywhere. It will not interfere with any electronic burglar alarms, fire or smoke detector, TV reception or other electronic equipment.

SET UP A BARRIER TO KEEP PESTS OUT THIS WINTER.

When you get your PEST-PRUFE you'll begin to notice some results in a few days. In two to six weeks your infestation will be eliminated. Then continual operation of your unit will prevent further nesting and inhabitations.

Even with colder weather approaching, you can keep pests from coming indoors as long as your PEST-PRUFE is in operation.

JUST PLUG IT IN.

There's no installation with PEST-PRUFE. All you do is plug it into any 110-Volt AC outlet. The solid-state electronics and quartz crystal speaker require only 5 watts of power—just pennies per month—and it's maintenance free.

Put PEST-PRUFE anywhere: home, apartment, store, warehouse, or factory. It's the perfect answer for facilities where food is stored or handled such as schools, hospitals, and nursing homes.

It will repel pests from areas that are difficult to seal-off such as garages, farm outbuildings, boats and vacation homes. One unit protects an area up to 2500 cubic feet.

YOU CAN'T BUY BETTER PEST PROTECTION.

PEST-PRUFE is state-of-the-art technology. Until now, commercial units used by professional pest control companies cost up to $200—but lower cost solid-state components allow PEST-PRUFE to give you the same pest repelling power for only $49.95 (plus $2.85 shipping and handling). Now there's no need to empty messy traps or buy poisonous chemicals again and again.

TRY IT FOR 30 DAYS WITHOUT RISK.

We urge you to try the PEST-PRUFE unit for 30 days. If you don't see proof that it is the most advanced, efficient pest eliminator available today, return it for a complete, no-quibble refund—including return postage. You are protected by a one-year manufacturer's warranty as well as Shelburne's 26-year reputation for satisfied customers.

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To order, simply send your check for $49.95 plus $2.85 shipping and handling to the Shelburne Company at our address below. Credit card holders can speed their delivery by using our toll-free number.
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Get rid of rodents and insects without using messy traps or poisonous chemicals. Let PEST-PRUFE clear your home promptly and effectively. Order one today and try it for a full month at no obligation.

PEST-PRUFE is effective in repelling:

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Roaches	**Carpenter Ants**
Crickets	**Silverfish**
Water Bugs	**Locusts**
Fleas	**. . . and many other pests**

Note: In spite of some claims, studies show that ultrasound is not effective in controlling bats or spiders.

The Shelburne Company

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Oxyozosynthesis

—quick fix for sludge

Fast ozone treatment kills bacteria in municipal waste

By PAUL BOLON

For the first time, ozone has been used to purify sludge in a quick, industrial-type procedure. Tested in West New York, N.J., for over a year, the new process, called oxyozosynthesis, turns sludge into a burnable residue in just 90 minutes.

The technology may have a major impact on the nation's cities, many of which are hard pressed to meet environmental standards on shrinking budgets. Its inventor, Dick Edwards, claims that operating costs of oxyozosynthesis are about half that of the city's previous disposal technique—a strong dose of chlorine followed by ocean dumping outside of New York's harbor.

But to prepare sludge (the solids in sewage effluent) for ocean dumping, it's not enough to simply kill the bacteria with a strong shot of chlorine. The large amount of remaining organic matter—40 to 70 percent of the total mass—promotes rapid regrowth of microorganisms in the ocean, stealing much of the oxygen needed by other marine life.

Chlorinated sludge is also too gassy and unstable to be used as landfill. Today most inland municipalities keep sludge in ponds or concrete holding tanks where "friendly" bacteria digest and break down the organic content. It's a long meal, though. The digestive process takes two or three months, and considerable land area is required for the ponds.

In contrast, oxyozosynthesis is a well-controlled chemical process, and the entire pilot plant for West New York, serving over 40,000 people, was tucked into a 20-by-40-foot room in the city's antiquated treatment plant.

The first step in oxyozosynthesis is to add a small amount of sulfuric acid to the sludge (water with five percent or more suspended solids at this stage), and then pump the mixture into a closed steel tank until it is half full (see drawing). The tank is pressurized with ozone as the gas is continuously bubbled up through the sludge. Simultaneously, sludge is pumped to the top of the tank and sprayed down through the ozone atmosphere.

After 60 minutes of the ozone bath, the sludge gets the same treatment with pure oxygen for 30 minutes. The mixture is then pumped out, and the floating solids skimmed off and pressed into a gray, cardboard-like sheet.

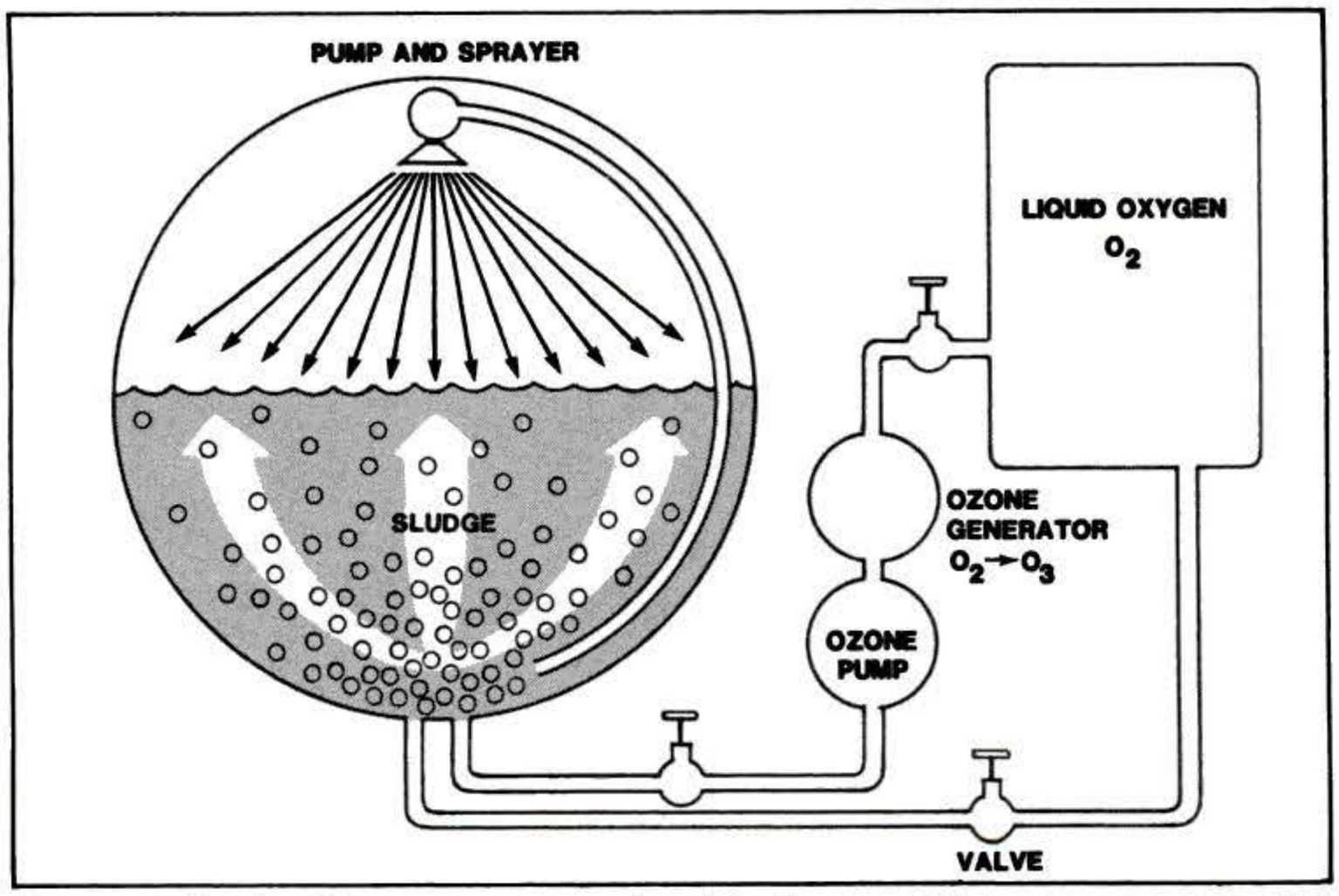
The quick-drying residue is free of bacteria, odorless, and inert—the ozone serves as a catalyst to decompose the organic matter. The residue makes an almost ideal landfill material, experts say. And if traces of heavy metals are removed at an earlier step, it can be safely burned as a fuel, producing about as much heat as wood or soft coal.

Development of an efficient, self-contained sludge technology had been a difficult problem for sanitary engineers, who labored for decades to find an alternative to nature's slow bacterial solution. Considerable interest had centered on oxygen and ozone, which were known to kill the bacteria found in sewage. Ozone worked in small experiments, but results outside the lab were hit-or-miss. Dick Edwards experimented for over 10 years to find the right ingredients to cause the oxygen-ozone process to both sanitize and break down the organic content of sludge.

Edwards, like many inventors, also had trouble turning his idea into a viable enterprise. Eventually he collaborated with businessman Robert Zabady to form International Wastewater Reclamation, Inc.

To prove that the concept was practical, Zabady decided to build a pilot plant at his own expense. West New York was especially receptive—the city faced a deadline and penalty if it failed to upgrade its ocean-dumping practice. Its treatment plant, perched on the Palisades overlooking Manhattan, was hemmed in by highrise apartment buildings and homes; there was no room to build additional tanks or ponds.

The oxyozosynthesis system has been processing about 20,000 gallons of sludge a day for West New York and has been in operation for about a year and a half. But just recently, Zabady was given a three-year license to use the residue as landfill in New Jersey's meadowlands—an area normally closed to all dumping.



Oxyozosynthesis: Ozone or oxygen is aerated through the sludge that fills the bottom half of the tank while the liquid waste is pumped upwards and sprayed into the remaining gaseous space. After only 90 minutes, the tank is drained and the remaining solids removed and pressed into cardboard-like sheets.

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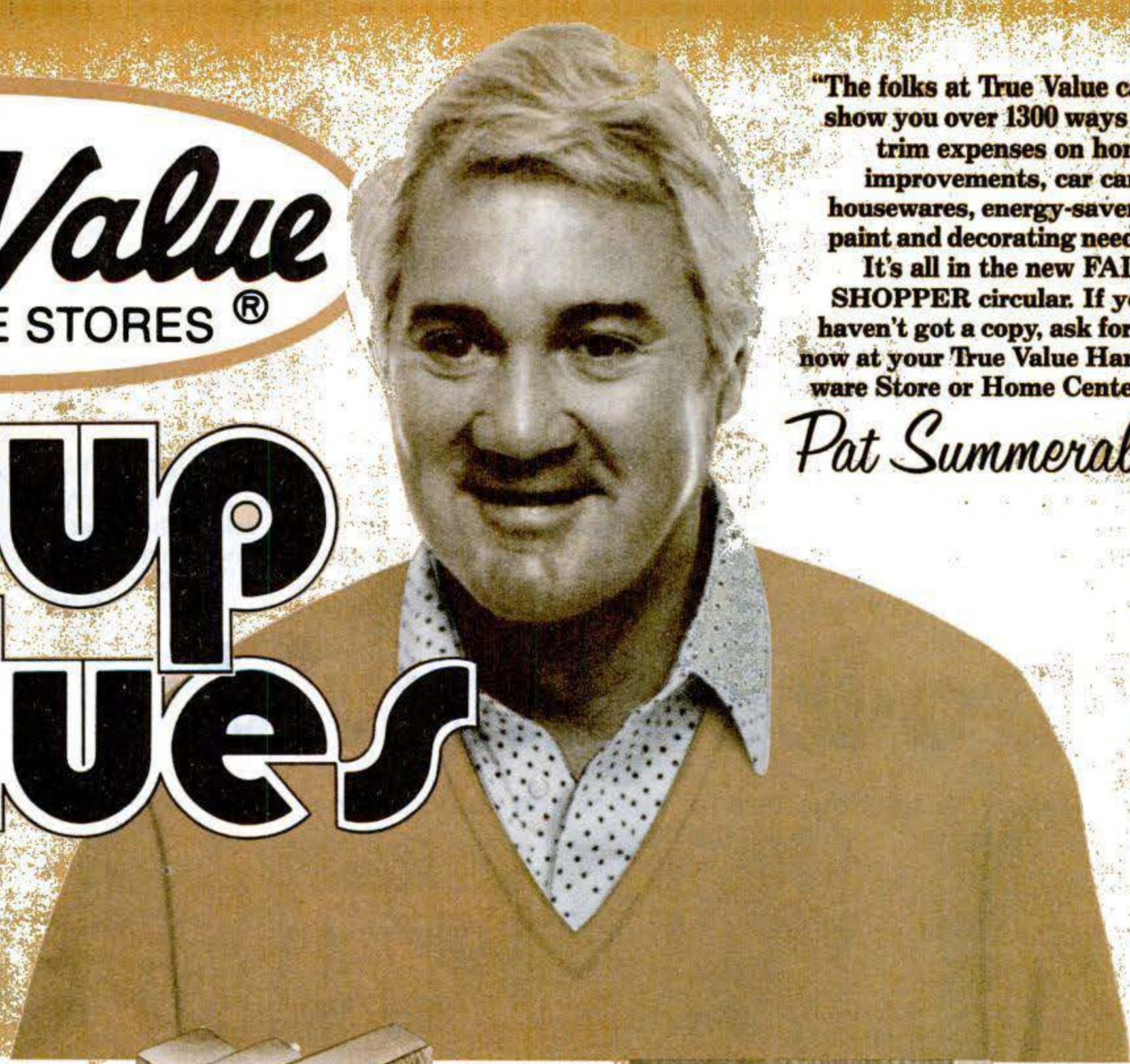

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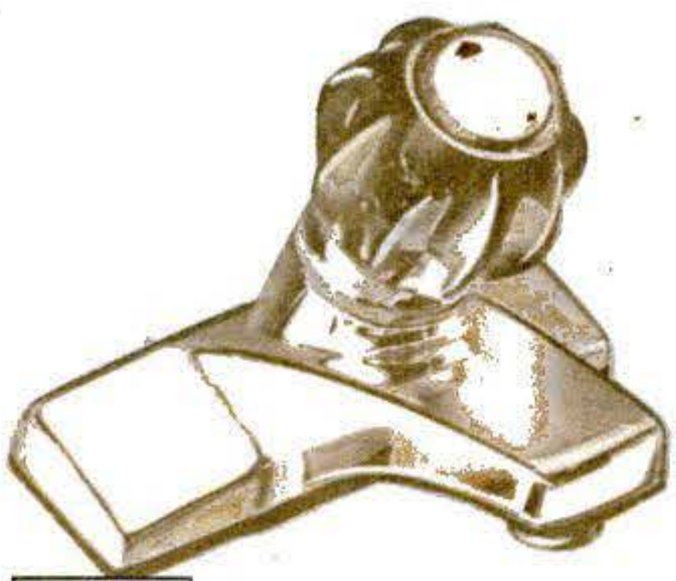
Pat Summerall



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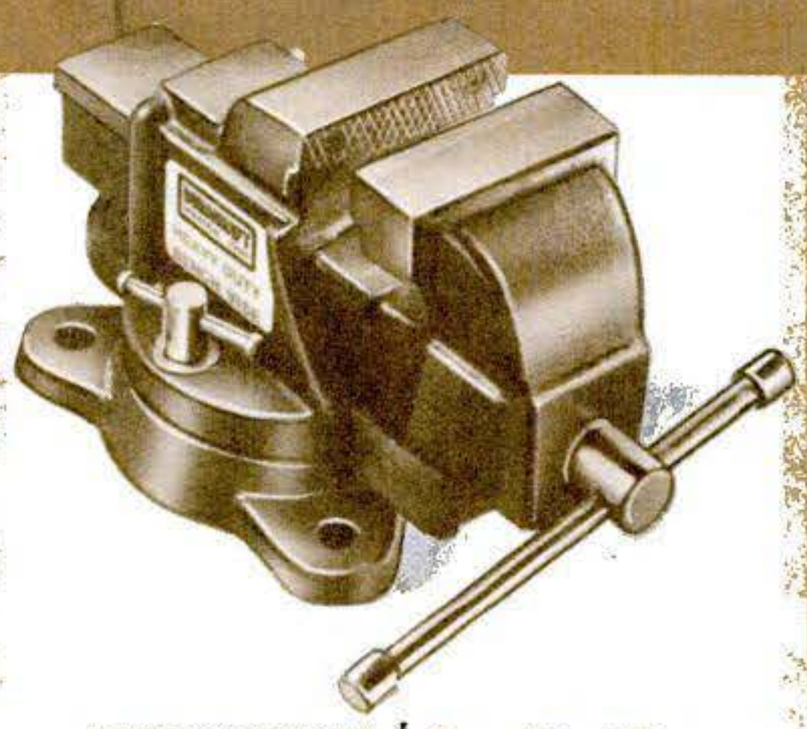

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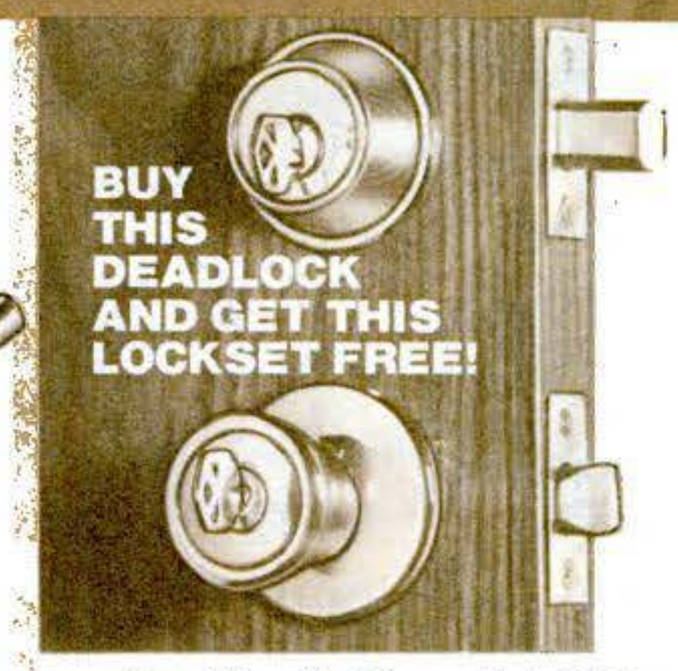

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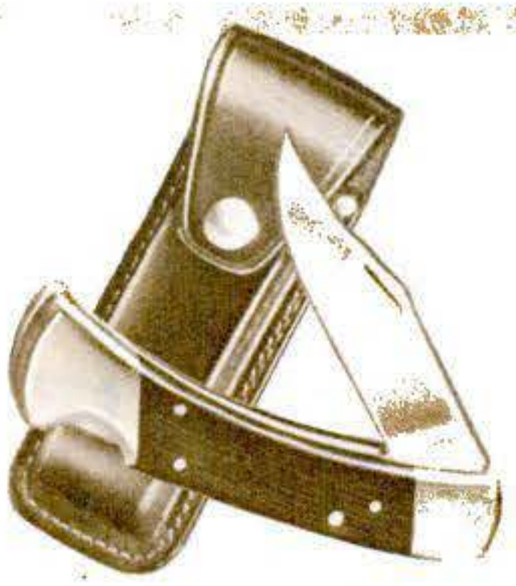

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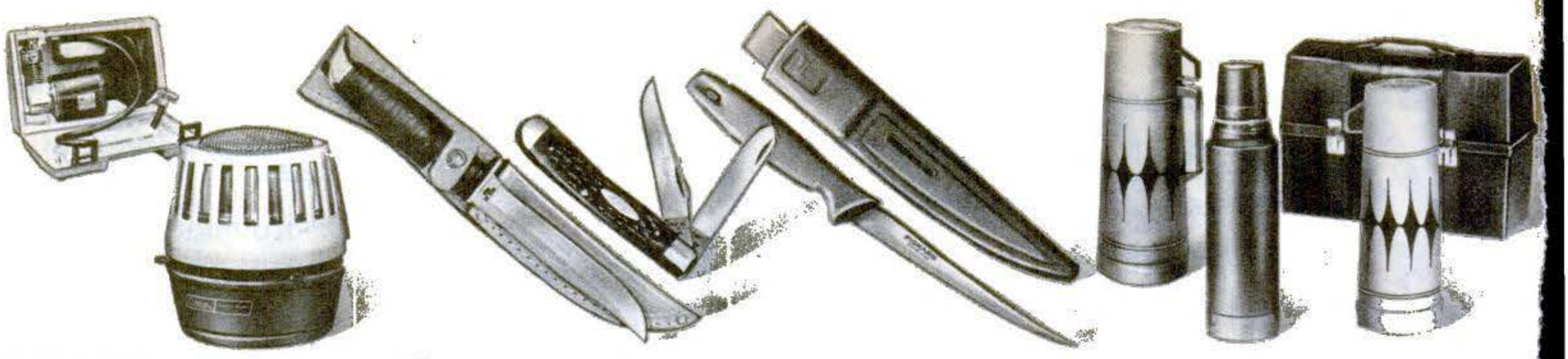
2 for 1

With this coupon get 2 keys duplicated for the price of 1! Single bitted only. Limit 1 pair per customer. Offer expires October 30, 1982.

TEAR OUT AND SAVE THIS 8-PAGE SHOPPER.

True Value HARDWARE STORES®



Coleman Power Pair
Inflate-All® plugs into lighter, pumps flats fast. 2239D641 . **32.88**
Portable 5000 BTU catalytic heater gives hours of warmth, without flame. 513B708 . . . **47.88**

Case Sharp Combo
Tru-Sharp surgical steel blades have glaze finish & polished edges. Pick trapper pocket knife with bone handle or 5" hunter's with sheath. 6207/3165SSP . **18.88**

FISKARS Sharpens
Sharpen this 6" filet knife anytime with its built-in sharpener in a sheath! Surgical stainless steel blade is dishwasher safe, may be worn or stored. 6290 . . . . . **9.99**

Aladdin Store 'n Pour
Vanguard® qt. thermos. 43D **4.44**
Virtually indestructible all steel qt. vacuum bottle. A944C . . **19.99**
Workman's kit holds man-size lunch, qt. bottle. 543D **6.88**

Do·it·right with savings

Make your headquarters for indoor and outdoor home care one of over 6,000 True Value Hardware

MORTELL Sealers
A Your choice 1" x 45' or 2" x 25' weatherstrip tape. TT45/25-2. Ea **1.99**
B Unroll pliable 45' caulk cord and press into place. Won't harden. F4 . . **1.59**

md Stop Cold
C Seal-O-Matic™ 36" door bottom blocks cold when door is closed **7.77**
D Nu-Koil vinyl and aluminum 17' weatherstrip cuts drafts. . . **2.99**

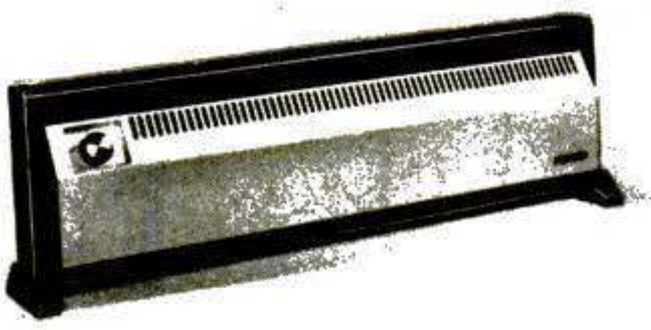
3M Weatherstrip
E 10' tubular or (12) 1' butyl rubber strips . **1.55**
F 15' flue tape **2.88**
G V-seal strip. White/brn. 90' . . **14.99** 17' . . **3.77**
H 30' clear tape . . . **1.99**

Frost King Cover
Outdoor air conditioner cover of "winterized" plastic is elastized for a snug fit. AC2 . . . . . **3.44**
3/8" x 17' white adhesive foam tape. L341 . . . . **88¢**

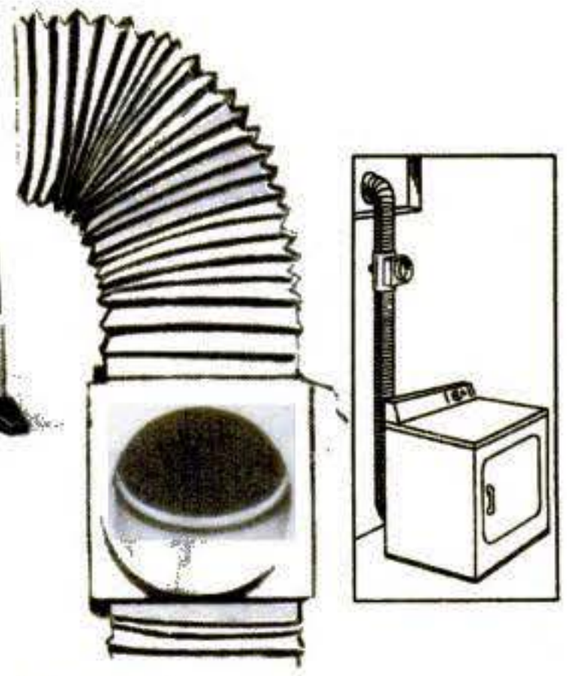
Edison Heater
Pulls in cold air and discharges fan-forced hot air to heat room. Thermostat controlled with 2 heat settings for different room sizes. 324036 . . . . . **39.99**

DENNIS Weatherstrip
Install a barrier against dust, drafts. 36" triple seal vinyl and alum. door sweep. 905 . . . . **2.77**
17" innerseal strip. BIS 17 . . **4.88**
Alum. & vinyl door set. 79-V **7.99**

Tip Top Tapes
Stock up now and save on 60-yd. masking tapes. C1221-4. 3/4" . . **49¢**
1" . . **69¢** 1½" . . **99¢** 2" . . **1.39**
Heat-resistant 2" x 60-yd. duct tape seals leaks. R92T **4.44**



INTERTHERM Softheat™ II
Deluxe portable baseboard heater safely circulates comfortable hot water heat wherever warmth is needed. 750W unit has built-in thermostat. NP750 . . . . . **79.99**



Lambro Econo-Mizer
Turn the clothes dryer into an extra energy source! Diverts moist, warm air into your home in winter. Close the valve for normal air flow. HM1700 . . . . **5.99**

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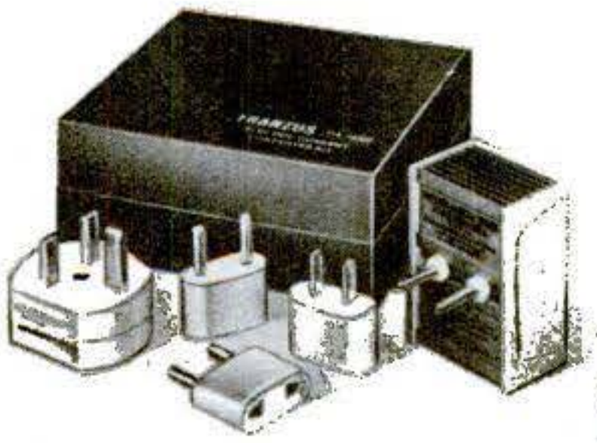
DURACELL Alkaline

Keep a ready power supply on hand. Choose 9V, 2-pack "C" or "D." MN1604B/1400B2/1300B2 . . **1.99**
4-pack "AA." MN1500B4 . . . . **2.79**
2-pack "AAA." MN2400B2 . . . **1.59**

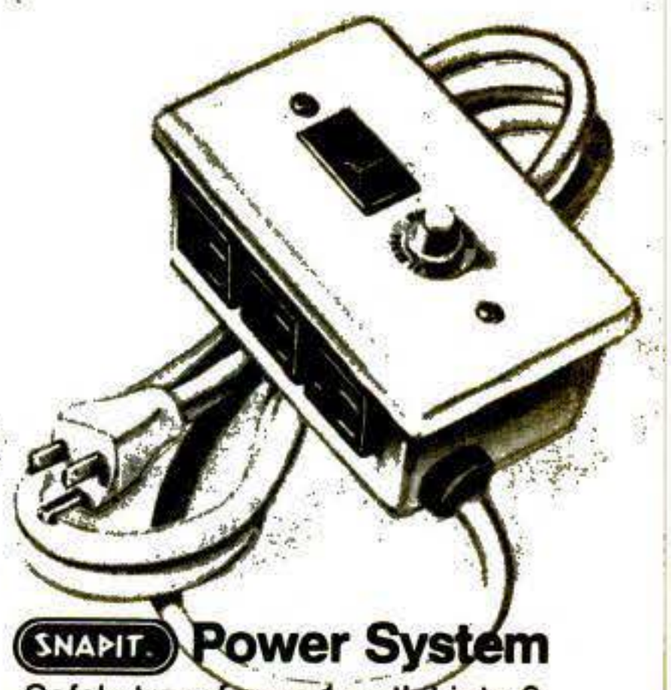
EVEREADY Energy Source

Keep your home and shop in top running order with batteries built to last! Shop a complete selection of general purpose and alkaline Energizer* batteries.



FRANZUS Travel Power

A must for foreign travel, 5-pc. kit converts 220/240 foreign voltage to 110/120 U.S. for appliances up to 1600W. With travel case. CA1600 . . . . . **19.99**



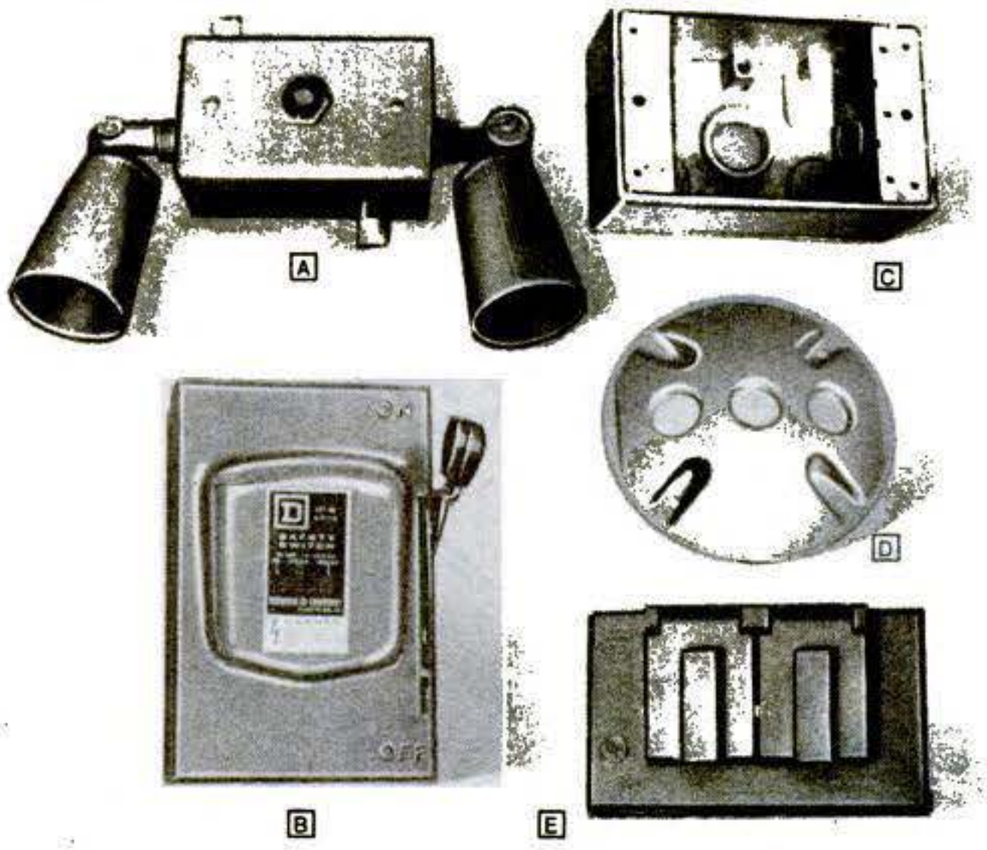
SNAPIT Power System

Safely transforms 1 outlet into 6. Mini-breaker protects against overload. Shock-safe, unbreakable housing for wall mounting or portable use. 48725-6 . . **11.88**

now thru Oct 30

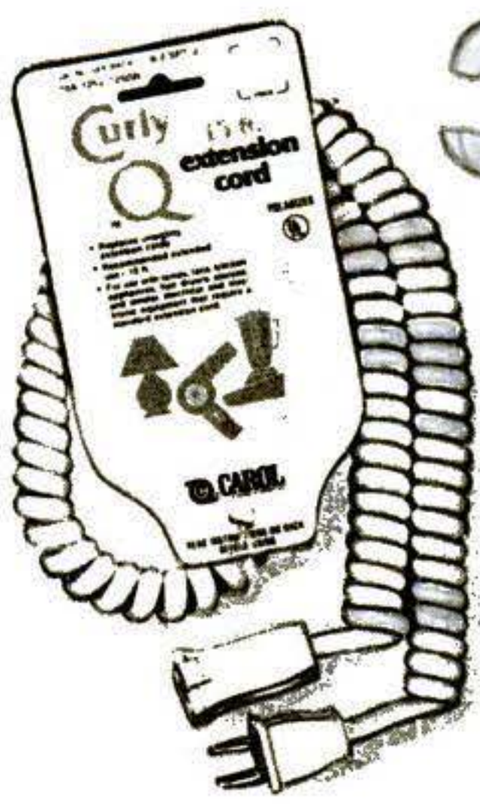
Stores. Look under "Hardware" in the Yellow Pages.

True Value HARDWARE STORES®



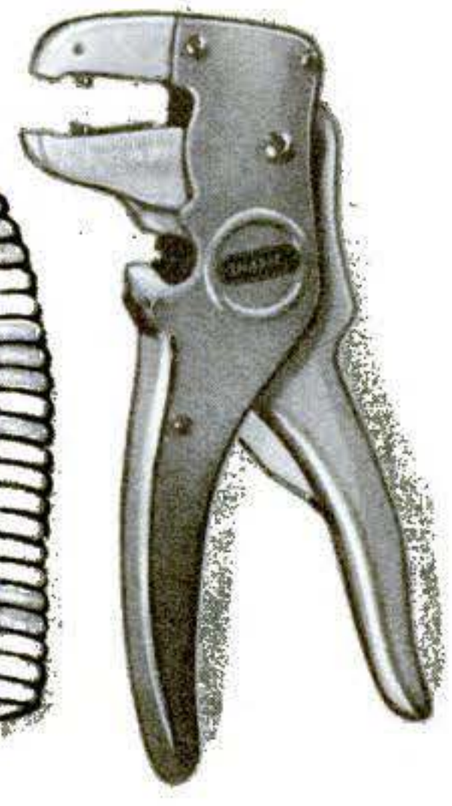
TRINE SQUARE D COMPANY Weatherproof Wiring

A Night Guard dusk-to-dawn light uses 2-par 75W or 150W lamps. 10840-G **18.89**
B 30-amp indoor safety switch. D211N **14.99**
C Rectangular 3-outlet box cover. 10270L . . **2.29**
D Round 3-outlet box cover. 10383 . . . . . **1.69**
E Die-cast duplex snap cover. 10245B **1.66**



CAROL Curly Q™

Replace worn cords on lamps, fans, appliances, with 18/2 retractable extension, 12' recommended usage. White, brown. UL listed. 6002/8 . . . . . **3.49**

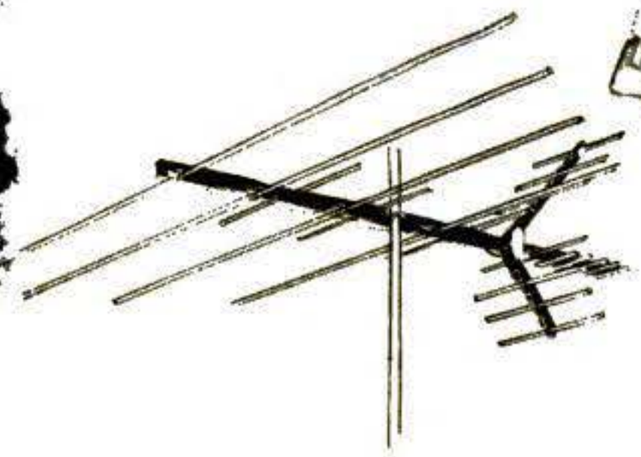


SNAPIT Cut 'n Strip

Great new idea for the do-it-yourselfer! Streamline repairs on appliances, cars, electricals with the tool that cuts and strips wires to 14 AWG . . **6.99**

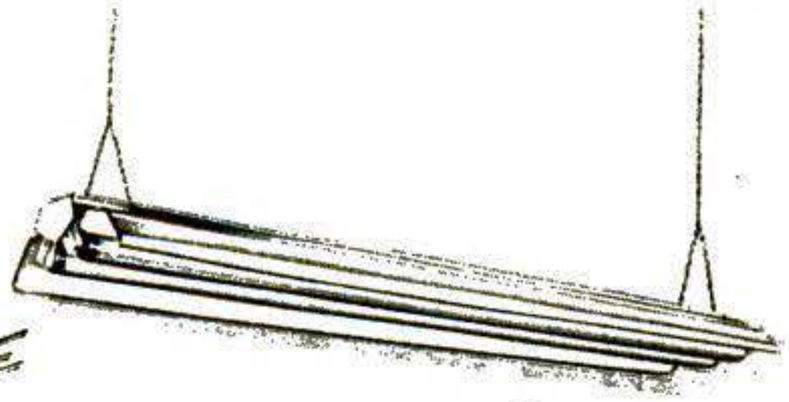
ITT Brite Beam

Ideal for lighting tennis courts, driveways, patios, walks, 300W quartz lamp sheds more light than two 150W incandescent lamps. R500Q2 . . . . **28.99**



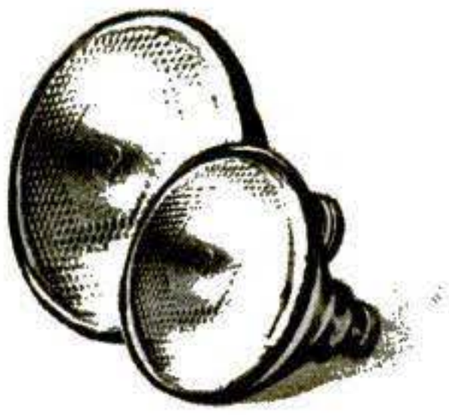
DUR-O-PEG TV Values

VHF/UHF/FM antenna. . . **19.99**
Universal transformer. B4644 **1.89**
Cable wall plate. B4647 . . . . **1.79**
75' coax TV cable. B4640 . . **8.49**
Coax 2-way splitter. B4646 . **2.89**



American Fluorescent Light

Illuminate workshop areas with all steel 48" rapid-start light. Completely wired, with two 40W lamps, 3-wire cord, plug and 24" hanging chain. 240SPLKD . **13.99**



GE Miser Floodlight

For home security or decorative lighting, the "Miser" offers energy-saving outdoor illumination. Choose 65W or 120W lamp. 65PAR/120PAR/FL/WM. Each . . . **2.99**

EDISON LIGHTING Colonial

Spruce up the porch or garden with matte black finished 60W lanterns. Choose semi-ceiling, wall or post-mount fixtures. E3226/3626/3726-9. Each . . . **16.66**

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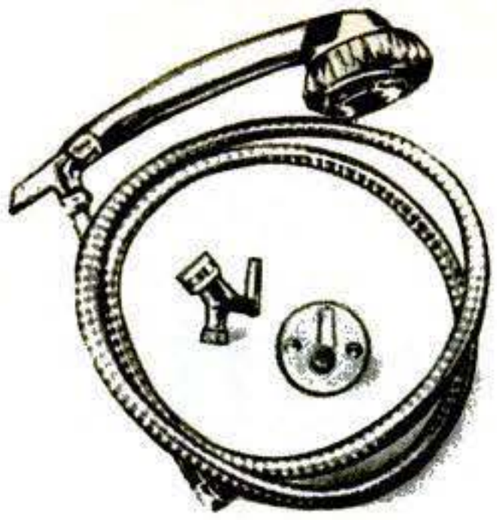
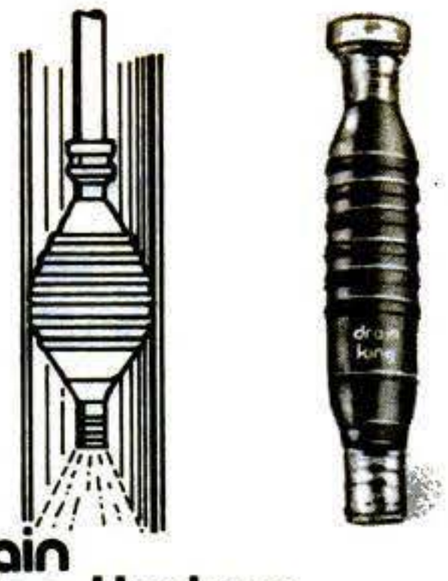


Add An alsons

Replace an old showerhead with push-button Personal Shower™ that can be hung or hand-held. Has wall mount, swivel connector, 59" hose. 410PB-PK **17.95**

SaverShower

Save up to 75% on hot water bills! Deluxe showerhead with throttle valve lets you adjust flow from full spray to trickle. SS2C **8.95**
Standard SaverShower. SS1C **5.99**



drain king Unclogs

Unclog sinks, tubs, toilets, more with water power, not chemicals. Attaches to hose, expands to fit pipe, then jets of water dislodge clogs. For 1-6" drains. 186 . **5.99**

True Value Sump Pumps

Cast iron ⅓-hp pedestal, overload protected. TVSPV500 . . . . . **59.95**
½-hp upright. TVSPV800 . . . **79.95**
⅓-hp submers. TVCDU790 . **72.95**
½-hp submers. TVCDU800 . **88.95**

Piping hot values now

The newest, finest fix-up products plus expert how-to advice give you

Fulflo® Purify Water

Install under the sink for better tasting water. Carbon filter removes odors, sand, rust, algae. With hardware. WT6 . . . . . **36.95**
Extra cartridge. RWT-3 . . . . **6.99**

Master PLUMBER

Faucets

A Cast in brass with bright polished chrome finish. Easy install centerset faucet replaces lavatory mount. 201-14MP . . **12.95**
With pop-up. 80MP. **18.95**
B 2-handle chrome polished kitchen deck faucet. 261-20MP **15.95**
With spray. 40MP . **19.95**

True Value Disposer

C Long-lasting blades chew up tough garbage, even bones, fast. Continuous feed operation, is sound insulated for quiet operation. Resists jamming and corrosion. ½-hp unit has quick-mount installation. TV103 . . **49.99**

Polar Steel Sinks

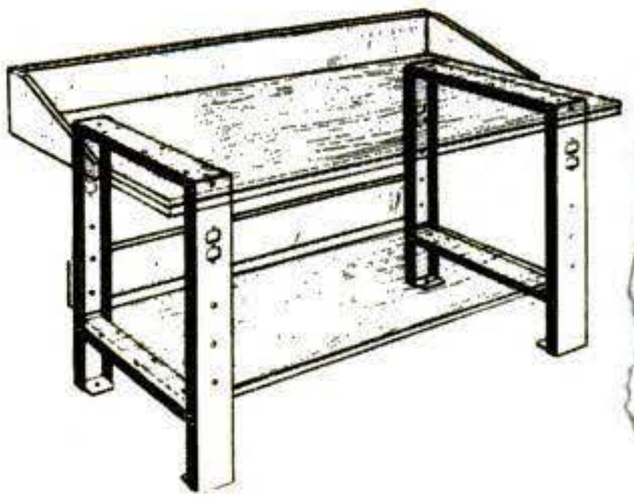
Stainless steel 1-pc. unit has pre-drilled faucet holes, installs fast.
D 2-bowl. 533E . . **35.95**
Single bowl. 522E **29.95**
E Utility and bar sink. K1559B **39.95**

plaskolite Shower

Hi-impact stall won't rust or leak, installs easily. Includes shower head, curtain, grab bar, faucet.
32x73¾". SS1000 . . . . . **119.95**
High-base stall. SS2000 . . **159.95**

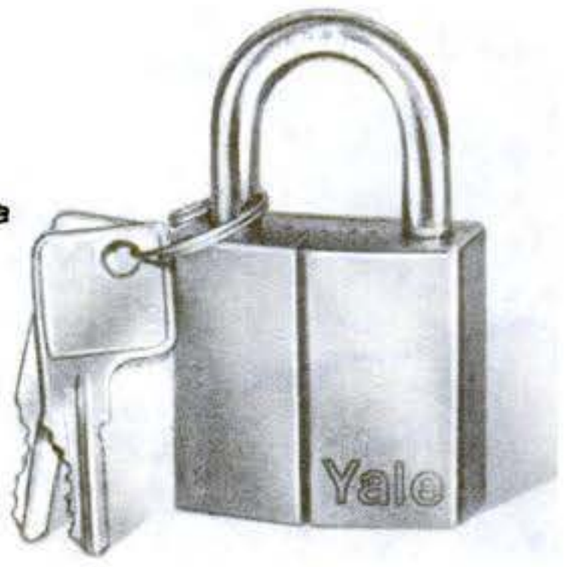
NEMCO PRODUCTS COMPANY Dryer Kit

Fully-assembled dryer vent kit has aluminum hood, duct, tension-type clamps. Easy to install.
4" diam. 5' long. AF45K **5.49**
4" diam. 8' long. AF48K **6.99**



Steel City Bench Legs

Set of sturdy 18-gauge steel workbench legs with hardware is all ready to assemble. Has handy spaces for outlets, tools. Top not included. WB-1R. Pair **12.88**



Yale Secures It

Powerful 4-pin tumbler padlock has 1¾" wide solid brass case, hardened steel dual locking shackle. Rust-resistant. 2 keys included. V7314 . . . . . **9.49**

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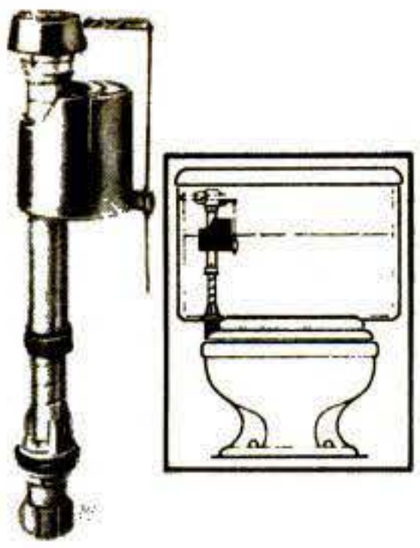


FLUIDMASTER

Non-corrosive FLC valve puts an end to toilet leaks and noises without float-ball or water pressure problems. Fits most standard tanks. 400A **4.99**

MELARD Auger

Drain-cleaning tool bores easily through clogged pipes to free obstructions. ¼" spring steel wire will not snag or catch. Easy to use 15' line. 1761 . . . . . **6.99**

BY PRICE PFISTER **Valve Values**

Replace rusted or leaking valves with solid cast brass gate valve. Handles to 200 lbs. water pressure. ½" gate valve. V05-020 . **2.99**
¾" gate valve. V05-030 . . . . . **3.79**

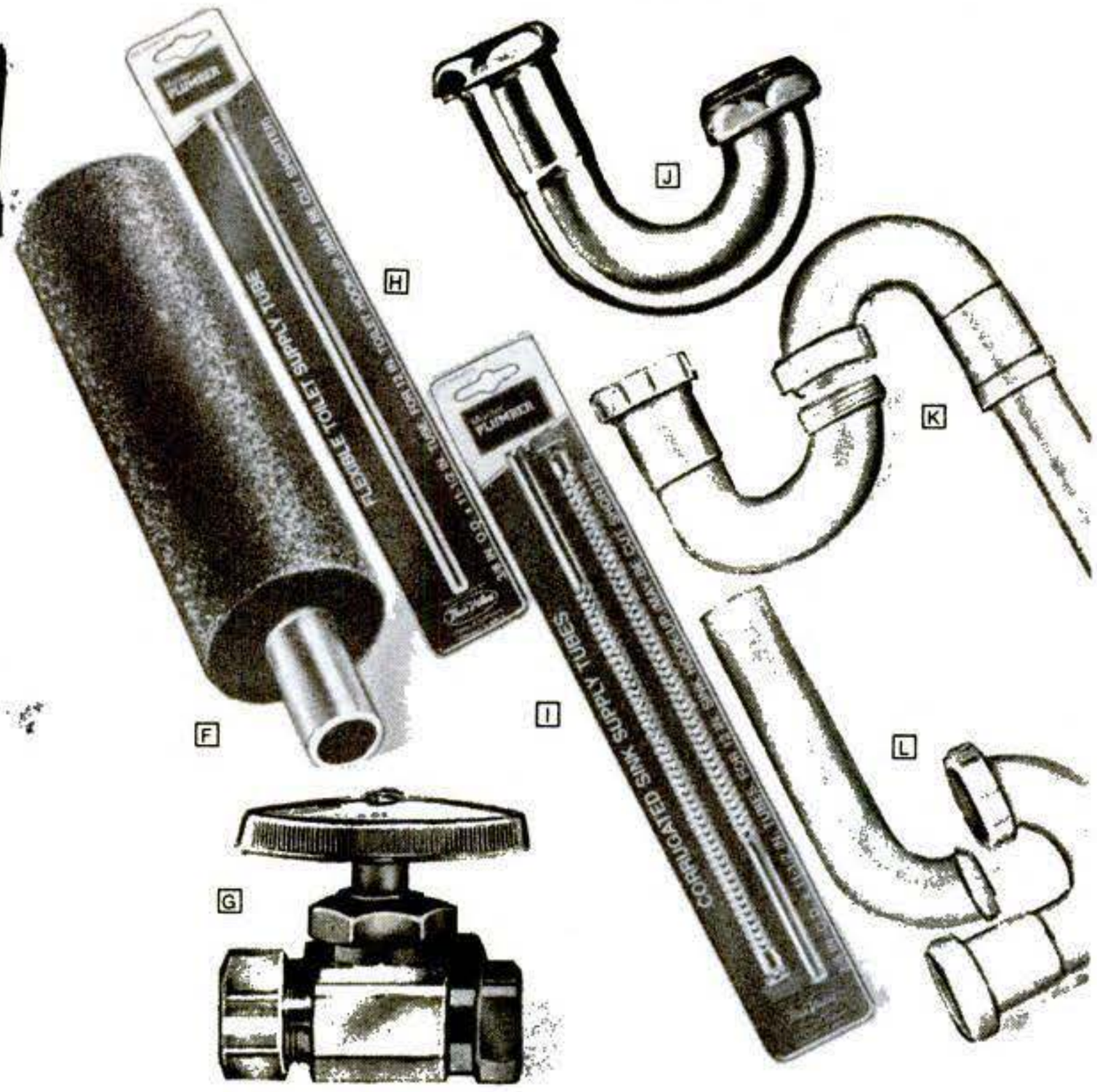
"Don't forget to pick up a copy of True Value's new FALL SHOPPER circular."

thru Oct 30

professional results when you do-it-yourself. Just say "charge it"

MasterCard VISA

True Value HARDWARE STORES ®



Master PLUMBER

Pipe Insulation

F Slip polyethylene foam on pipes to stop heat loss, sweating, freezing, reduce fuel costs.
For ½" copper pipe. 338C50M . **2.99**
For ¾" copper pipe. 338C75M . **3.49**
For ¾" steel pipe. 338C100M . **3.99**

Water Supplies

G ½ x ⅜" compression straight valve for iron pipes. MP20 . . **3.49**
½ x ⅜" angle valve. MP18 . . . **2.99**
H 12x⅜" toilet supply tube. **1.59**
I 2-pack 12x⅜" corrugated supply tubes for sink. MP60 **3.99**

Sink Repair

For repairs or remodeling, opt for corrosion-resistant parts.
J Chromed "J" bend. TV1PC . **2.99**
K Plastic "S" trap. TV66-3 . . **3.99**
L Plastic "P" trap. TV940 . . **2.49**

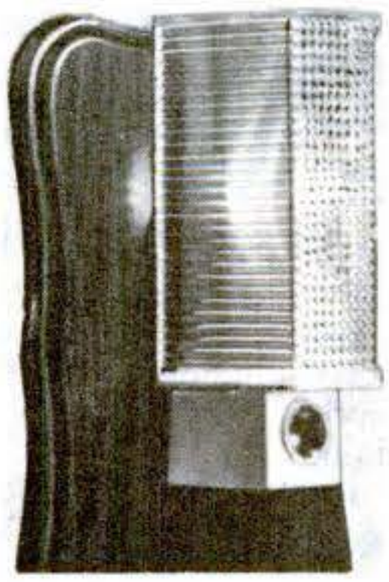
Check our low prices!

National **Ornamental**

Sturdy antique black bracket adds stylish support to bookshelves, hanging plants, curio display. 8x5½". 152 Each **2.77**
10x7" bracket. 152 Each . . . **3.19**

KinderGard. Childproof

Keep poisons and sharp items out of reach of small children with self-locking safety latch. Extra strong hook design secures cabinets, drawers. 3-pack. 103 . . **2.49**



NOVO Sense the Night

Automatic night light "senses" night and day to turn on and off; varies the output of light proportionately to the degree of darkness. Uses 7W bulb. NL300 . **2.88**

True Value **Energy-Saver**

Energy-efficient water heaters pay for themselves in savings on fuel and installation costs. Thick foam insulation retains heat, uses less energy, gives you hot water when you want it! Your choice of 30-gal. natural gas or 40-gal. electric water heaters. 5-year warranty. Each **114.95**

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Wet-Dry Vacuum picks up everything from water to nails. With 6'x1¼" hose, 1½" wand, 10" nozzle, squeegee shoe and plastic dolly. 6-gal. cap. MM600-6. **54.25**

Portable Workbench is first with movable vise! Holds materials to 27" wide, folds to 5" flat. Has tilt adjustment, 5 open positions, 4-position legs and tool holder. MM1000. **49.99**

12-Piece ⅜" Drive Socket Set, forged from alloy steel, contains 7 sockets, ratchet, ⅝" spark plug socket, speeder disc, more. SAE or metric. MM812P/M. Each set **10.99**

Brazing Torch Kit, with fuel mixture feature, lets you select right fuel for each job, from propane to high-temp Mapp® fuel. Has tips, regulator, rods, 16-oz. tank, and more. MM3600. **16.95**

True Value HARDWARE STORES®

Professional

YOUR CHOICE 6.99 each

Professional Tool Chests have tough "strongbox" construction with sturdy solid steel throughout, reinforced tops, full-length hinges and compound drawer slides. Stacked or used separately, they are big enough for a workshop full of tools. Keyed cylinder locks and baked-on enamel finishes for years of use.

Ⓐ **6-Drawer Chest** has 3 large and 3 smaller drawers, 4-section lift out tray. 15x26x13½". MM1806. **92.99**

Ⓑ **3-Drawer Roller Cabinet** has large storage area, brakes on two casters. 33½x26½x18". MM1903. **117.99**

Ⓒ **Flat Top Tool Chest** with 3-section tote tray, socket divider plus padlock eye. 20" long. MM920. **12.99**

Ⓓ **7" Diagonal Pliers,** forged from alloy steel, is one tough tool for heavy-duty jobs. High leverage diagonal cutter is electronically hardened for superior strength and durability. Forged rivet for tough, precision fit. MM40-7C.

Ⓔ **2-In-1 Plane** uses Pro-Sand and Pro-Cut grater blades interchangeably to plane, shape, shave, file and sand wood, plastic, soft metal, and particle board. Pro-Sand blade outlasts sandpaper 100 to 1, changes in a "snap." 80570.

Ⓕ **Professional 24" Aluminum Level** has 6 unbreakable vials, 4 plumb and 2 level, sealed against dirt and moisture by heavy glass windows in die-cast frame. Convenient measuring rule on top in both English and Metric. 10106.

Ⓖ **Professional Screwdriver Sets** feature chrome vanadium steel blades for tensile strength without abrasion, and precision ground tips. Large comfort grips fit your hand for greater turning power. Your choice basic 5-pc. set with 3 slotted and 2 Phillips screwdrivers or 4-pc. set with commonly-used Phillips screwdriver sizes. TS5, TS4P. Each.

Ⓗ **3-Pocket Tool Pouch,** handcrafted of genuine top-grain cowhide, is as practical for the do-it-yourselfer as it is for the professional. Features easy-access main pocket for large tools, 2 plier pockets, 2 side slots for long screwdrivers, friction tape sling, knife snap and a 16" steel tape pocket. With extendable belt slots. Overall size: 8½" x 9¼". MMLP438.

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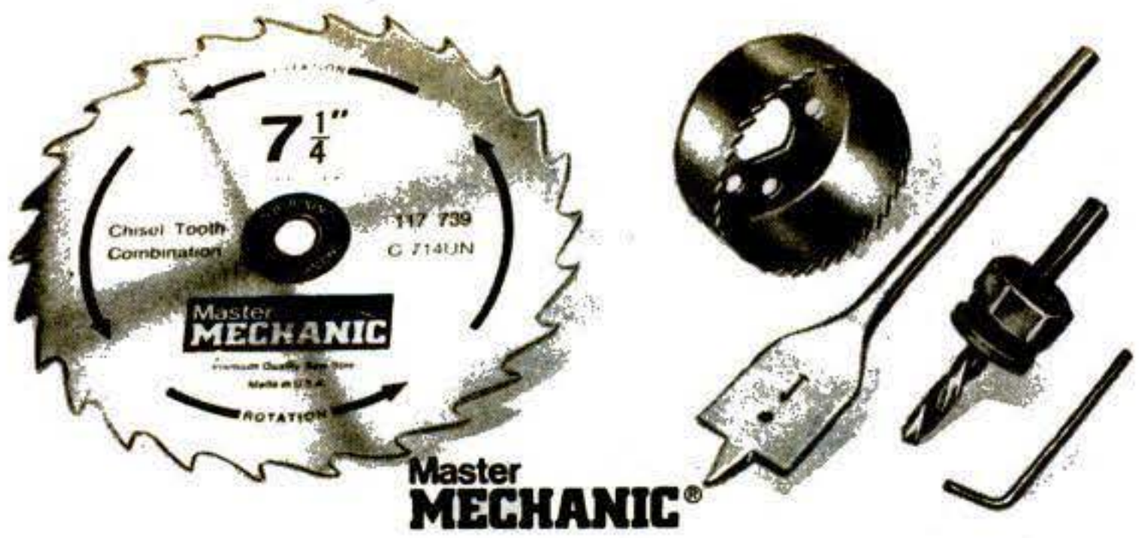

7¼" Combination Blade with hard chrome finish will rip, crosscut and miter in soft and hard woods. Chisel tooth makes it ideal for framing and cutting of heavy woods. 117739. **2.99**

4-Pc. Holesaw Set cuts wood, plastics, composition materials for lock/deadbolt installation. Made of carbon steel, set has 1" woodbit, 2⅛" holesaw, mandrel, wrench. 397760. **6.99**

Mini Hacksaw handles any job a big hacksaw can do...and more! It's designed to adjust to work in close quarters. Heavy-gauge molded handle. Uses regular blades. MMHF10. **1.99**

6-lb. Splitting Maul has a drop-forged hand-ground steel head fitted to a fire-hardened hickory handle for strength and balance. Bites deep into wood with light ease. MMS6MA. **11.99**

quality tools

Master® MECHANIC hand and power tools are sold exclusively by True Value Hardware stores and carry this customer satisfaction policy: If any Master MECHANIC tool fails to perform as you would reasonably expect, return it to any participating True Value Hardware or Home Center for immediate replacement.

YOUR CHOICE 4.69 each

YOUR CHOICE 9.99 each

I **Home Safety Kit** is designed for use in the workshop and yard with goggles that fit over glasses, a non-toxic dust respirator, and earplugs. Protects user running power tools, chain saws. MM3.

J **17" Claw Ripping Bar** is high carbon steel forged for durability and strength. Has polished ripping blade, 3 nail pullers to extract deeply embedded nails and a 90° claw for tight spots. MM232.

K **12" Combination Square** gives the best angle on carpentry work. Markings are graduated by 8ths and 16ths on one side, 16ths and 32nds on other. Die-cast beam has level inscriber. 10245.

L **7-Pc. Drill Bit Set** is high speed steel, heat-hardened for maximum strength. Hardened power points bite deep for smooth, one-stroke drilling. Drill bit sizes range from 1/16" to ¼". 121590.

M **Professional-Quality Hammers** have highly polished striking heads, triple wedged handles in tapered eye. Handles are select, flame-treated hickory. Choose claw or ripping hammer. B16MM/RMM.

N **Single Bit Axe,** with its balanced hickory handle, is light enough for easy use, heavy enough to bite deep. Drop-forged from high quality tool steel and hand-ground to keep a keen edge. 35SBTT.

O **Precision Wood Chisels** make fast work of shaping wood or composition. 3-pc. set has ½", ¾" and 1" blades, austempered and bevel-ground to keep keen cutting edge. Hi-impact grips. 300MM.

P **Professional Power Tape** has self-adjusting end hook for accurate measuring. 25'x1" no-seam epoxy-coated blade housed in rugged, Cycolac® chrome-plated case. With removable belt hook. MMP425.

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National ¼" and ⅜" Socket Set

Streamline work on appliances, motors, cars with high-quality 41-pc. SAE and metric set. Has 33 sockets, ratchet, extensions, spark plug socket, more in metal case. C84-41AFM . **12.99**

Crescent® Adjustable Wrench

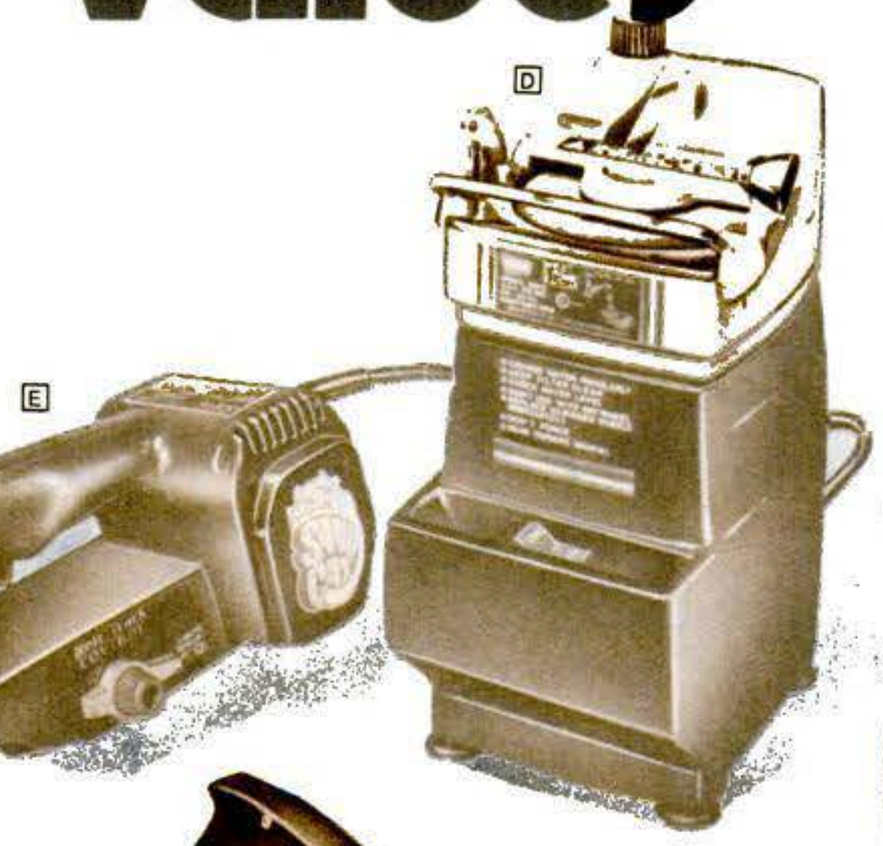
No tool box should be without this 8" alloy steel wrench. Drop forged and heat treated for toughness and durability. Completely chrome-plated to resist corrosion. AC18V **6.99**

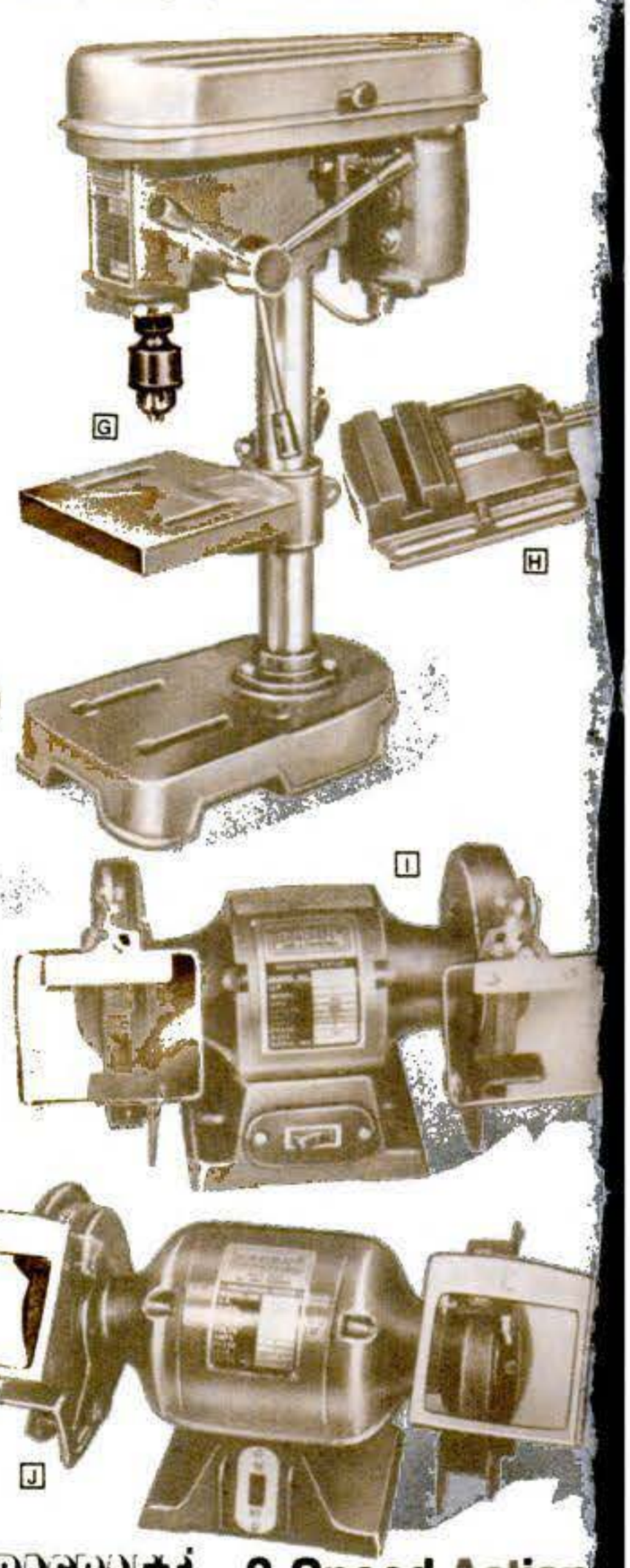
SerVess 14" Pipe Wrench

Drop forged upper and lower jaws with full-floating hook jaw assure instant grip and easy release. Won't jam on pipes. I-beam handle has handy hang-up hook. 514S **9.99**

True Value HARDWARE STORES®

fix-up values





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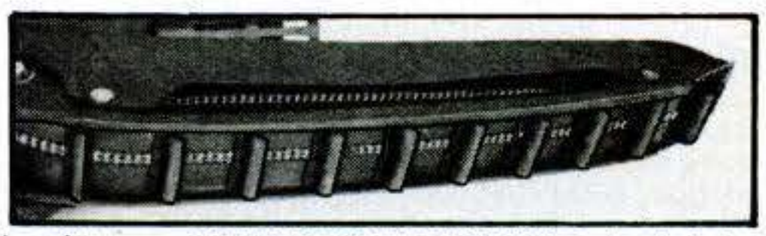

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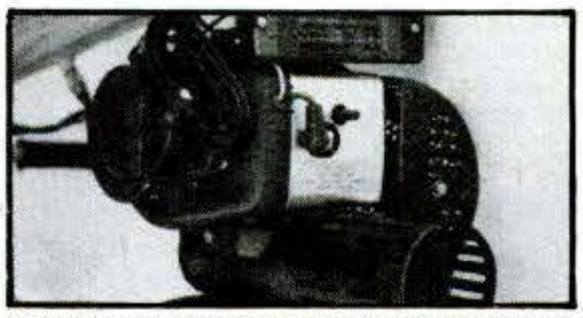

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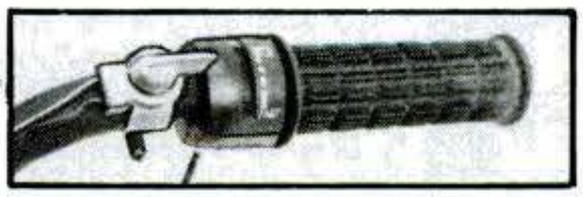

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Mazda's pickup gets a diesel

The diesel invasion continues, now with a new engine from Mazda that's nearly a twin in performance to its gasoline-fueled brother. With the introduction of the B2200 diesel pickup in the spring of this year, Mazda numbers itself with diesel builders that have drawn widely on automotive technology's tricks to battle noise, sluggish acceleration, and slow starts—laments common among diesel buyers.

Mazda also claims to have the lowest-priced diesel truck on the U.S. market. Suggested list price for the standard version is $6,745.

The B2200 made available to POPULAR SCIENCE for a town-and-country test drive proved to be an able workhorse. Piston clatter, even under full-acceleration stresses, was minimal. Mazda uses expansion-control aluminum pistons and steel piston sleeves to cut the clatter. Other noise cutters include heavy-duty soundproofing at the fire wall and throughout the roomy cab, a temperature-modulated cooling fan that also prevents overcooling and resultant power loss, and a silent fan gear.

On the road, the B2200 handles crisply. But like many small diesels, it doesn't like hills, where the drop in speed is noticeable. With its stiff suspension and factory-new shock absorbers, it also gives passengers a choppy ride over the slightest road imperfections.

Rated payload for the B2200 is 1,400 pounds. The truck comes only with an 86-inch-long bed, which is 57 inches wide and 16 inches deep.

Thanks to a newly developed control system, I had no problem starting the truck. On 55-deg.-F Los Angeles mornings, the 2,209-cc (135 cu. in.) power plant consistently fired up in less than four seconds and settled into a smooth idle.—*Jim Schefter*

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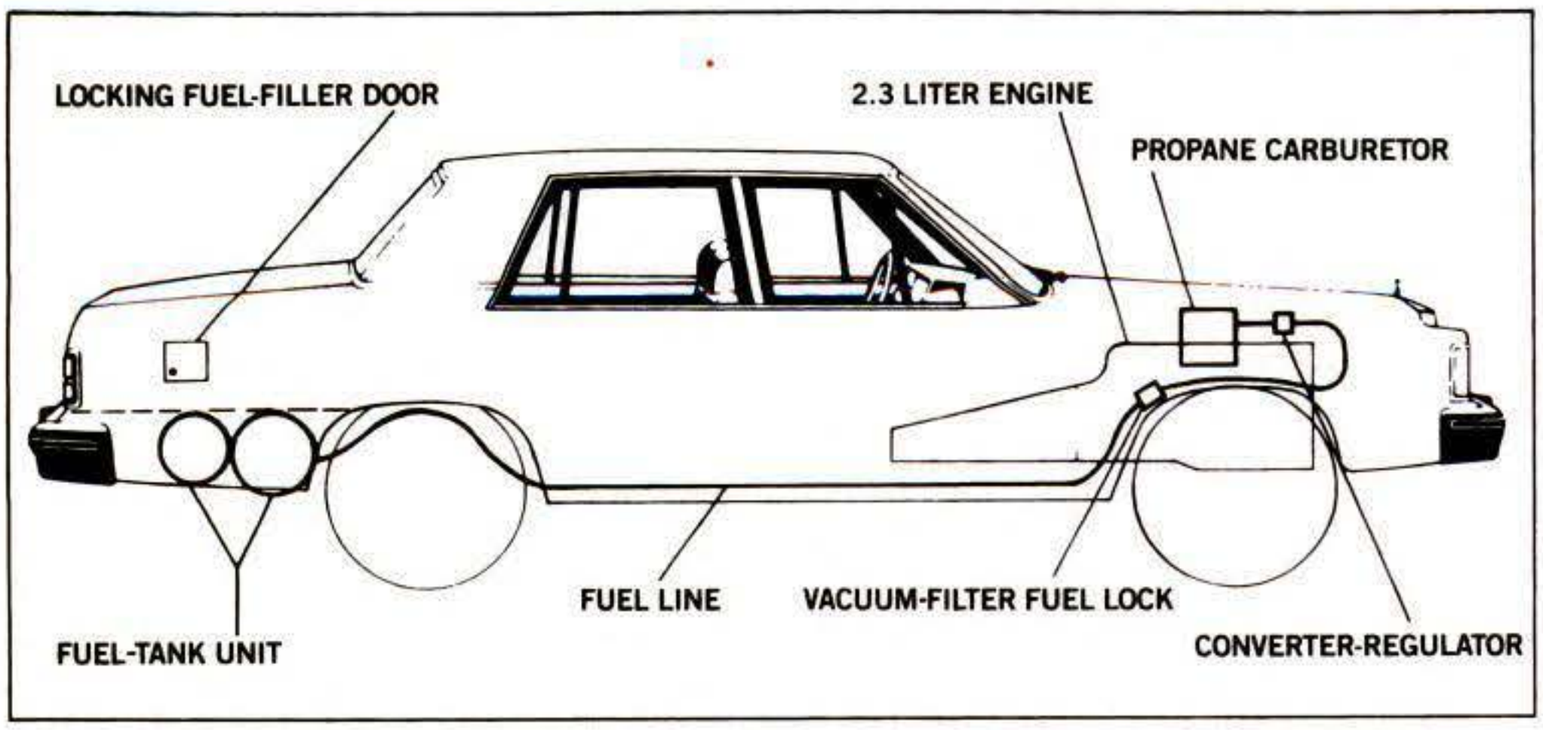
propane Granada from Ford



They're available to fleet owners today; everyone can order the option in '83

By JACK KEEBLER

"What's the mileage like?"

"Around 16. The best I've gotten is 18.4 and the worst, 13.7."

"And you're paying me $1.10 a gallon? What's the point?"

That's how the conversations usually went with the attendants who topped off the tanks in my propane-powered Ford Granada GL. I drove the car for 1,500 miles, experiencing the delight of the engine's wonderfully smooth performance and the misery of searching for propane outlets (the closest one to my house was 10 miles away).

Why propane? Of all the alternative fuels now under consideration, propane is perhaps the most practical. It could well be an important fuel of tomorrow for cars.

Although the propane option is now available only to fleet owners, Ford will offer it—for approximately $900—to *all* buyers in 1983. Today, however, propane is not for everyone, unless, of course, you own a fleet of cars or you're a farmer with access to bulk-rate fuel.

Even John Hartzell, director of communications for the National LP-Gas Assn., admits that "at present the propane car is not aimed at the general public. But fleet owners can realize huge cost savings. What really matters to them is not miles to the gallon, but miles to the dollar." (The association publishes an essential accessory for propane cars: a directory to U.S. propane outlets.)

From that perspective, propane is very cost-effective. My fuel costs ranged from 79¢ a gallon at a large propane distributor to $1.50 at a New York State gas station. In addition, it's claimed that spark-plug life is doubled—or even tripled.

Because propane is introduced into the induction system as a gas—not as a liquid, like gasoline—lubricating oil is not washed off the cylinder walls. Result: a reduction in both engine wear and oil contamination. That means longer intervals between oil changes and engine overhauls. It's not unusual for a propane-powered fleet vehicle to run 200,000 miles without a major overhaul.

Propane vehicles don't have fuel pumps. They don't need them. Propane, although a gas at atmospheric pressure, is stored under pressure (130 psi at 70 degrees F) as a liquid in the vehicle's fuel tank. At the converter-regulator (see drawing) it expands to its gaseous form and is then ingested by the special propane carburetor. Because the carburetor does not need to vaporize a liquid or mix the fuel and air, its design is simplified.

There are some minor points to be aware of concerning propane-fueled vehicles. At very high ambient temperatures, the system will occasionally vent itself. (Liquid propane expands as it's heated.) This may be slightly dangerous, but only if the vehicle is parked in a confined area where the vapor cannot dissipate.

Another gremlin shows up in very cold weather, say minus 30 degrees F. The fuel pressure drops, and the car may be hard to start or may not start at all.

Driving impressions

Granada's 2.3-liter four-cylinder engine runs and idles beautifully. I've driven V8's that weren't as smooth as this little four-banger. Its compression ratio has been bumped up to 10:1, and the distributor advance has been recalibrated to take advantage of propane's 100+ octane rating. The engine feels sprightly, and that's saying a lot considering the automatic transmission and the 3,000-pound curb weight. The propane option itself adds 121 pounds to the standard Granada or Cougar.

The car's handling left a lot to be desired, despite the special suspension package designed for the extra weight of the LP tanks. The car went on rebounding after even the slightest road irregularity. One driver was inspired to write in the log book that the car "pitches like a cabin cruiser." PS

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John MacNaughton, the flint-hard distilleryman, who, years ago, came to Canada to create the North Country's silkiest Canadian, did not believe in diluting "the great ones." "Whiskies like mine should be let to speak for themselves," he said. We agree that "on the rocks" or "straight" is the test of a great Canadian. But in these slightly more temperate times, if you like a little soda or your favorite mixer in your whisky, at least you'll be starting with one of the best Canadians money can buy.

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"SAY, SMOKEY—"

A clinic on cars by Smokey Yunick, America's most famous mechanic

Unhappy truck owner

I recently purchased a 1981 Ford 300-cu.-in. six-cylinder F-100 pickup. It runs like it's being fed gas through an eyedropper. The motor tends to surge and miss slightly at any speed except idle, making it miserable to operate at speeds lower than 50 to 55 mph. If it's lugged at slow speed up an incline, it seems okay. I've had it to my Ford dealer several times. He says they all run the same, that the emission system causes it. When I see the TV ads I just wonder if I have two left feet. I do get 21 mpg (empty) on long trips, though.

Kenneth Kay, Great Falls, Mont.

He guessed the problem: too much emissions junk. Spark, fuel, temperature, and EGR are balancing acts, and the results are terrible. We need to back up to 1980 emissions standards: Put some fuel in it, throw away 10 lbs. of junk, and it will run—but it's illegal. I don't understand why Ford didn't buck for an emissions dropback, as GM did. Ford stared at the ceiling and said they were okay.

Diesel repair

I have been considering buying a General Motors diesel car or pickup but would like to know if you think repairs can be performed by a "backyard mechanic"—or do they require special skills, knowledge, and equipment that would cause repair costs to offset lower operating costs?

David C. Mullen, La Mesa, Calif.

No, you can't shade-tree it—no way.

Cramped compartment

I have a 1977 Volare station wagon with 225-cu.-in. Slant Six engine, and it's virtually impossible to loosen the distributor hold-down screw. I have both types of specified hold-down wrenches, and they don't work. Because of the cramped space I just can't get my hand in that area.

L. H. Woodward, Laredo, Tex.

A Snap-On tool will take you as close as you can get.

Worrisome wheels

We have a 1973 Buick Electra, which is still in beautiful condition. (The car has about 57,000 miles on it.) When we first got it we could put it up to 100 mph with no vibration. Our second set of tires were Uniroyals, and they caused no problems. About a year and a half ago we put four General tires on and immediately had vibration problems as soon as the car reached about 62 mph. We took the car back to General, and they replaced two tires—one on the rear and one on the front, rebalanced all, and replaced the front shocks. We still experienced the same vibrations.

We returned again, and General replaced all four tires with Poly Sprint-7 Rib tires, and we still had the vibrations. We again took the car in, wheels were balanced again—no improvement. These were all non-radial tires.

Would you have any clues as to what is causing the problem?

K. C. Ashley, Howard City, Mich.

Out-of-round tires or a bent wheel is my guess. You can balance a square block, and it will spin as smooth as glass. But it would ride rough and vibrate as a wheel.

How to store a car

I have a 1964 Studebaker under restoration and a VW-based kit car. The Studebaker has been in storage for three years and is started occasionally. The VW is stored during winter. One local source says fresh crankcase oil and a teaspoon or two of fresh oil in each cylinder is best for storage. Others say run the engine to operating temperature at least once a month. What's your advice?

Joe Podutt, Sun Prairie, Wis.

The main part of the game is to seal off oxygen to stop oxidation. How you get there is the problem. If you sealed the whole car in a plastic bag, you'd protect everything, but that's not practical. The best you can do is either drain and seal the engine, or fill the cylinders with oil and try to seal everything after that.

Engine replaced

I started using synthetic oil at 3,500 miles in my Chrysler Slant Six engine. At 44,000 miles the crankshaft developed approximately ¼ inch of end play. Pulling the pan revealed that the crank had worn through the number-three main-bearing flange and into the engine block. The engine had to be replaced.

The damaged engine sat for two weeks with the valve cover off. The valve springs and exposed parts were dry (with no oil film) and were starting to rust. This indicated to me that the oil drains off during shutdown.

Most of our driving is short trips. My question is: During shutdown, does this leave the perpendicular surfaces without lubrication when starting? I took this problem to the oil company involved, but their only answer was that their oil had survived strenuous endurance tests. I believe that, but does it protect an engine for short trips?

Clarence Borg, Rockford, Ill.

I think in your case the oil didn't do the job, and the consequences got expensive. Readers worked me over recently when I cautioned against any and all synthetic-oil use. I spent an awful lot of time looking at synthetic oil. I think it has super potential, but it must have an affordable price. So I'd say a lot of research and testing still needs to be done.

Popping noise

I own a 1968 Mustang with a 302 V8 engine. It has 91,500 miles on it. I burn Amoco premium unleaded gas. Compression in each cylinder is about 150 psi; manifold vacuum is 18 inches at idle.

My problem is a popping noise in the tailpipes as the engine is warming up. When operating temperature is reached, the noise is not noticeable.

Steven Christoffersen
Gainesville, Fla.

Popping in the exhaust pipe is caused by an exhaust valve leaking or remaining partly open—or by an ignition problem, where ignition occurs out of time and fires the cylinder with the exhaust valve open (as could happen, for example, with a cracked distributor cap).

It's all in the timing

I have a problem with my 1973 429 four-barrel Ford LTD, which has 73,000 miles on it. In the past 30 months the starter was replaced six times and the drive three times. The cables and starter solenoid were also changed and checked for high voltage, and the ground was checked. The armature gets burn spots on it. Ford mechanics are stumped. Can you help?

P. Mack, Lansford, Pa.

A worn timing chain retards timing, and this means higher-than-normal cranking effort.

New rear makes more news

My 1978 Chrysler LeBaron originally came with a 2.7 differential, which had to be changed. A 2.9 rear end was installed. Does this affect speedometer accuracy?

Patrick Astree
Cambria Heights, N.Y.

It sure does. You need to get a matching speedometer with drive gears to go with the axle ratio. The drive shaft now makes more revolutions per mile with that 2.9 differential.

Each month, Smokey Yunick answers questions on cars—family cars, high-performance models, and racing vehicles. Got a problem? Send it to: "Say, Smokey—", POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. All letters are read, and those of widest interest are answered in this column. Due to the large volume of mail, Smokey cannot reply to letters that are not selected for publication.

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Gas: The future belongs to the efficient.

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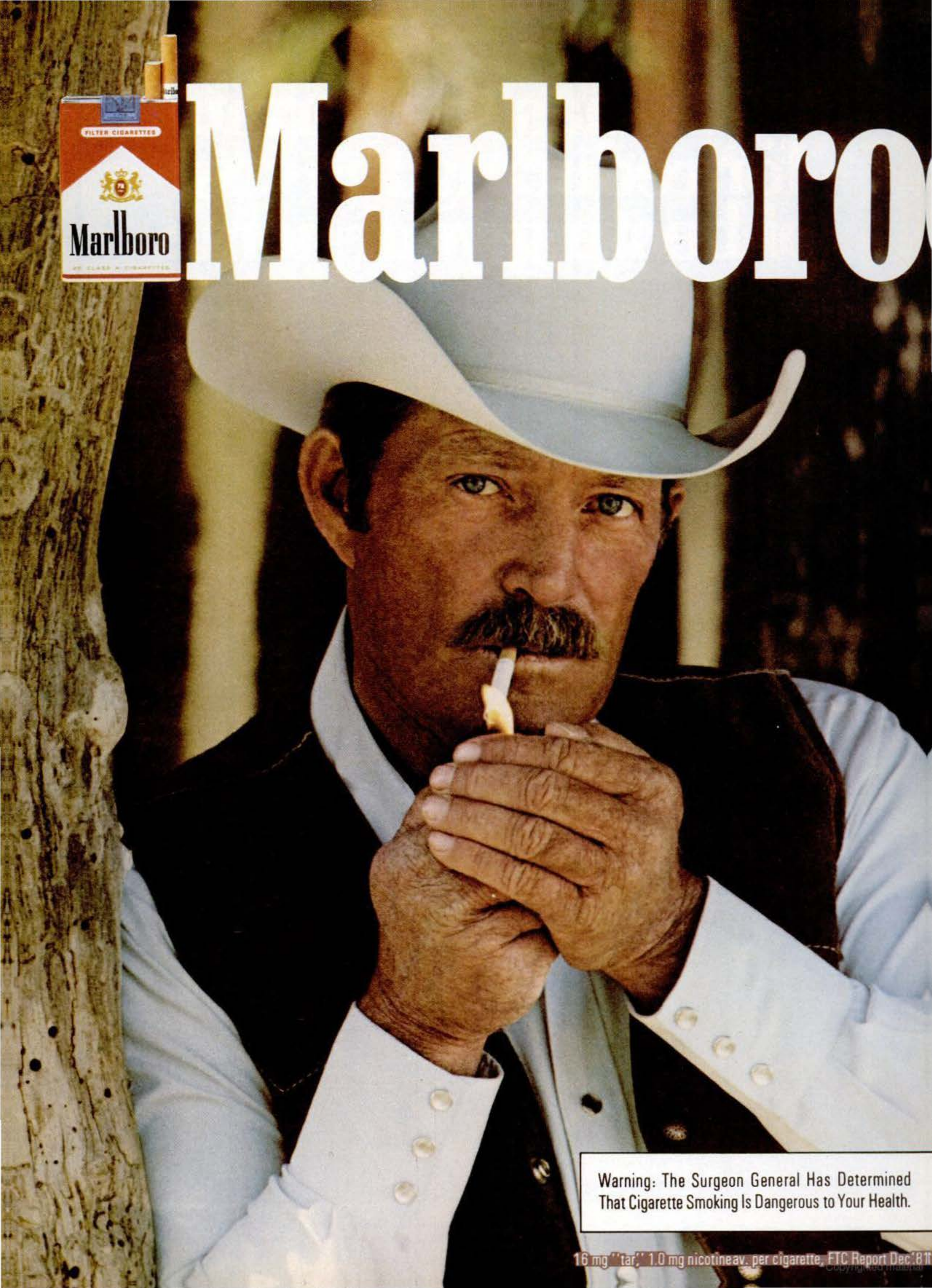
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Popular Science

PS | What's News

Incidents in the Falkland Islands and Lebanon this year astonished a lot of people. A British destroyer, the Sheffield, was hit and sunk by a single Argentine fighter plane firing a single French-made missile, the Exocet. In the Middle East, Israeli units knocked out batteries of Soviet-made missiles, then proceeded to shoot down 79 Syrian planes without a single loss to their own forces. Clearly, warfare has changed. A new generation of smart missiles has altered the way countries defend themselves. But while these two incidents may have surprised most civilians, they came as no surprise to military experts.

The new missiles—and the defensive strategies they spawn—grew out of a number of technological advances that have been reported in POPULAR SCIENCE over the years. They have now been put together in new and deadly ways. And that's something informed citizens should know about. Ed Edelson, a frequent POPULAR SCIENCE contributor who writes about the new smart missiles in this issue, says information was surprisingly easy to come by. With missile manufacturers hawking their wares on the international market like so many used-car salesmen, they were anxious to talk about them. Only specific performance figures were withheld. Edelson's article starts on page 74.

Shuttle business

The fourth and last shuttle test flight (from now on flights will be fully operational) carried an experiment of tremendous potential importance, both for the national space effort and for the companies that produced it. The experiment was a joint development by McDonnell Douglas and Johnson & Johnson. It involved the separation of biological substances in space by a process known as electrophoresis. Such a process can be used to make very pure interferons, hormones, enzymes, and other such medically useful substances. It works even better in the weightlessness of space, and, say the experimenters, manufacturing of such materials may ultimately be cheaper in space than on the ground.

The experiment was run under NASA's relatively new "joint endeavor" program, under which private companies and NASA share expenses. Further, companies are allowed to keep the results of their experiments secret. Until this provision was introduced, companies had balked at *any* experiments in space, because their results would automatically fall into the public domain.

This new way of operating could have profound effects on the future of the space program. Brad Marman, a NASA spokesman, said it will open space to private industry. And ultimately, he added, "private industry could get involved to the point where the space program would be paying for itself."

Cloudy future for rainmaking

Eleven years ago, when Rob Gannon reported on progress in rainmaking [PS, Sept. '71], the field seemed to have a rosy future and authorities were saying that commercial rainmaking was "scientifically possible and within sight." Alas, those days are gone and support for rainmaking is drying up as fast as a rain shower in the desert. Now the $10 million annual weather-modification research budget is about to be slashed to $4 million, with further funding soon to be "zeroed out," as they say in Washington.

The big problem grows out of an experiment that took place in Florida in the late 1970's. Experiments in the early '70's had produced what appeared to be good results. During the late-'70's period, planes flew into the Florida clouds a total of 51 days, not knowing whether the canisters they dropped each day contained silver iodide—the most potent cloud-seeding chemical—or sand. The idea was that after the experiment was over, they'd open the sealed records and compare the results. If the silver iodide worked, it should have produced significantly more rain than did the sand.

The results have been disheartening, and for a strange reason. One of the days when planes dropped canisters was July 29, 1978. On that day, the skies opened. It rained so heavily, in fact, that it upset the results of the entire experiment. It turned out later that that was a sand day. If you leave that day out of the experiment entirely, then silver iodide produced 28 percent more rain than did sand—a respectable showing. But it rained so much on that *one* day that it almost evened out the score; silver iodide produced only four percent more rain.

So while meteorologists connected with the project are pretty sure that the one day of big rain was just a fluke and that the rainmaking really did work, the official results show otherwise. And in the current climate of tight budgets, the country's research into weather modification seems sure to be dropped.

Briefly noted

- Turning an invention into a successful product is tough. Now the Small Business Administration has published a booklet that may make it a little easier. It goes into many aspects of the problem, from idea evaluation to legal protection, from venture-capital acquisition to production and sales problems. Single copies are available free from the Small Business Administration, Box 15434, Fort Worth, Tex. 76119.
- Do black holes really exist? The evidence is growing stronger that they do. Dr. Herbert Friedman of the Naval Research Laboratory has measured bursts of X-rays coming from the constellation Scorpius. The frequency of the bursts—82 times per second—and other characteristics lead the researchers to believe that they are coming from gases spinning into a black hole 35 miles in diameter.
- Teletext marches on. A number of experimental teletext services have been set up in cities across the country. Now CBS says that this fall it will offer affiliates a 100-page teletext "magazine" of sports, news, finance, and other information. NBC has been experimenting with a service in Los Angeles and says it will go national next year.
- Flying experimental planes is dangerous. I reported in March that two firms were building planes that would attempt to fly nonstop around the world without refueling. One of them was being built by Quickie Aircraft [PS, Aug. '81] and was to be flown by the company's president, J. Thomas Jewett. I am sorry to report that the plane crashed during testing and Mr. Jewett was killed.

Editor-in-Chief

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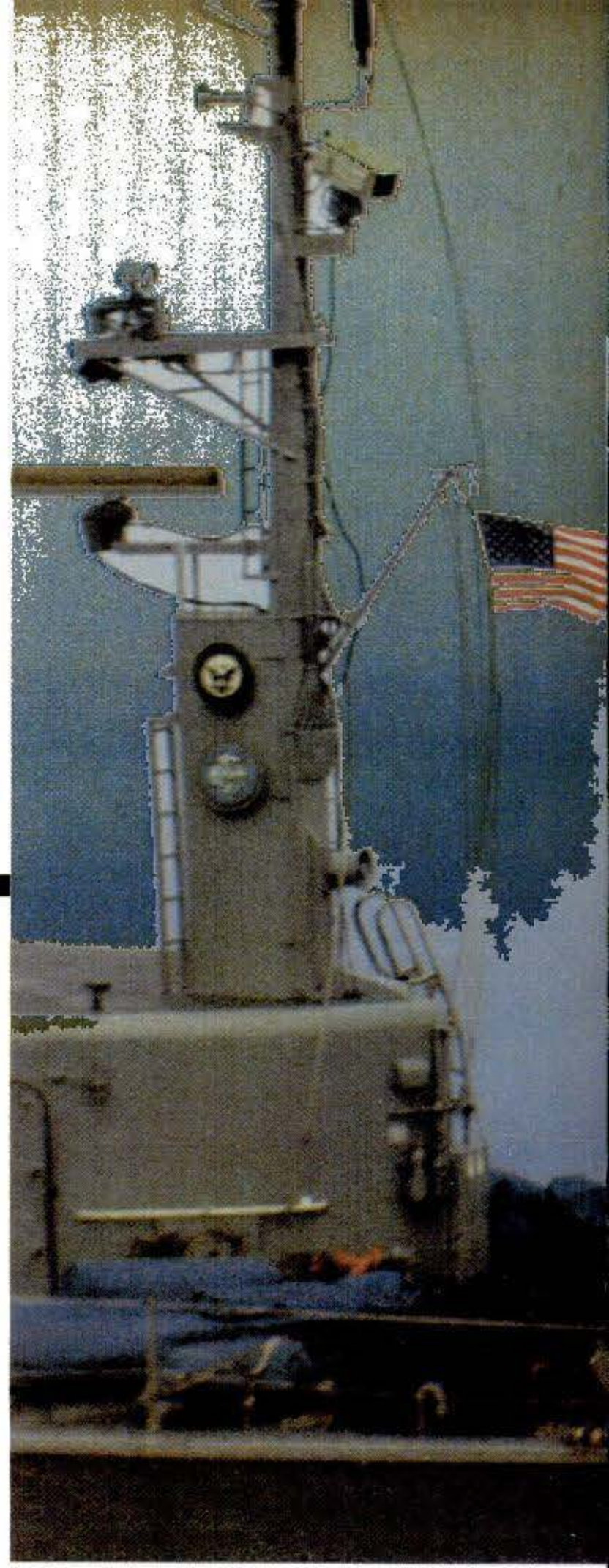
Engineering secrets of the new **smart missiles**



They're small and cheap —and nearly ubiquitous. Their sophisticated seekers make them deadly accurate

By ED EDELSON

It was a shot heard round the world. Last May 4, as the British fleet closed in on the Falkland Islands, an Argentine Super Etendard jet fired a single Exocet missile at the British destroyer Sheffield, some 20 miles away. Using a sophisticated inertial-guidance system and radar, the Exocet skimmed just above the waves and just below the speed of sound toward the ship. The missile gave only a few seconds' warning between the time it was sighted and the moment it hit. In minutes, the midship section of the Sheffield was an inferno and 34 British seamen were dead. In hours,

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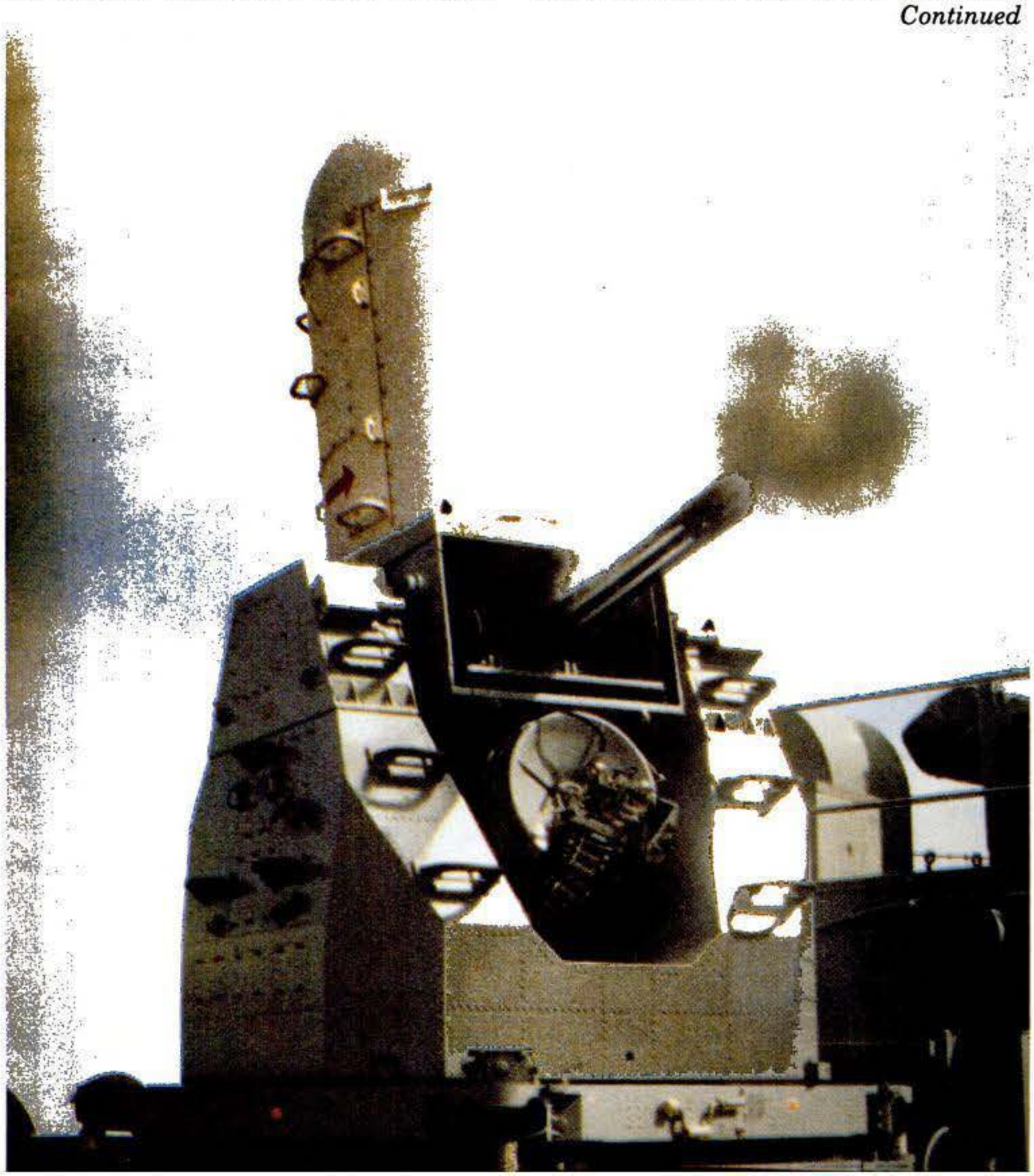

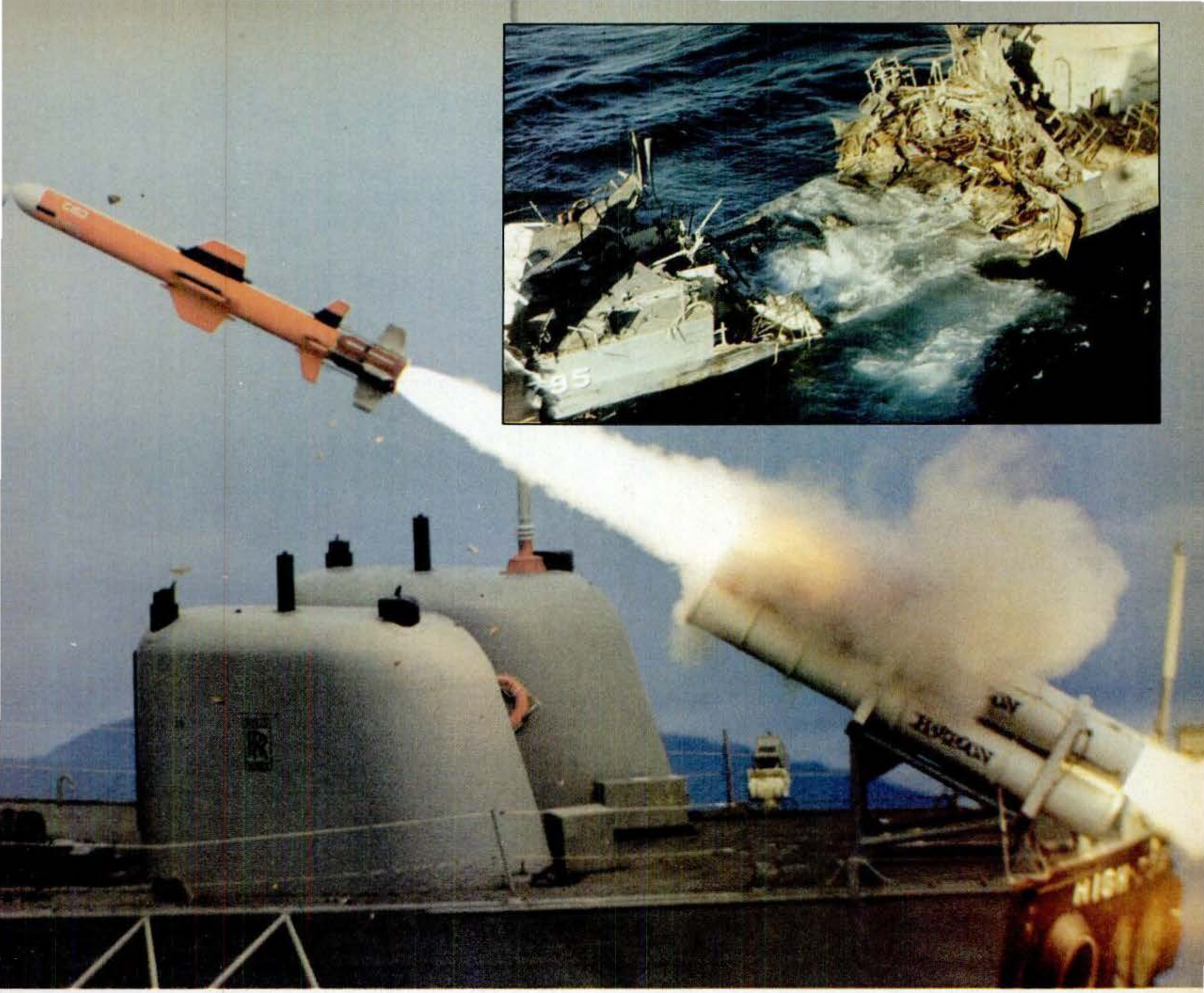

Radar-guided Harpoon missile (above), made by McDonnell Douglas Astronautics, can be launched from aircraft, surface ship, or submarine, and has a range of 50 nautical miles. It is an antiship missile (see inset) similar to the French-made Exocet, but it has a 500-lb. warhead vs. 360 lbs. for the Exocet (which was enough to sink the British destroyer Sheffield in a single blow). The Phalanx antimissile system (far left), made by General Dynamics, uses a radar-guided, computer-driven Gatling gun that blasts incoming missiles at a rate of 3,000 rounds a minute. Its ammunition is more potent than most because the core of each round is made of depleted uranium, the heaviest metal available, for maximum impact. About 11 percent of U.S. combat ships carry the Phalanx, according to analysts. The Tomahawk (left), a medium-range (250 nautical miles) air-to-surface missile is guided by an infrared image seeker in its nose. Now under development by General Dynamics, it can be used against ships or land targets. Here the missile attacks a runway with cratering sub-munitions.

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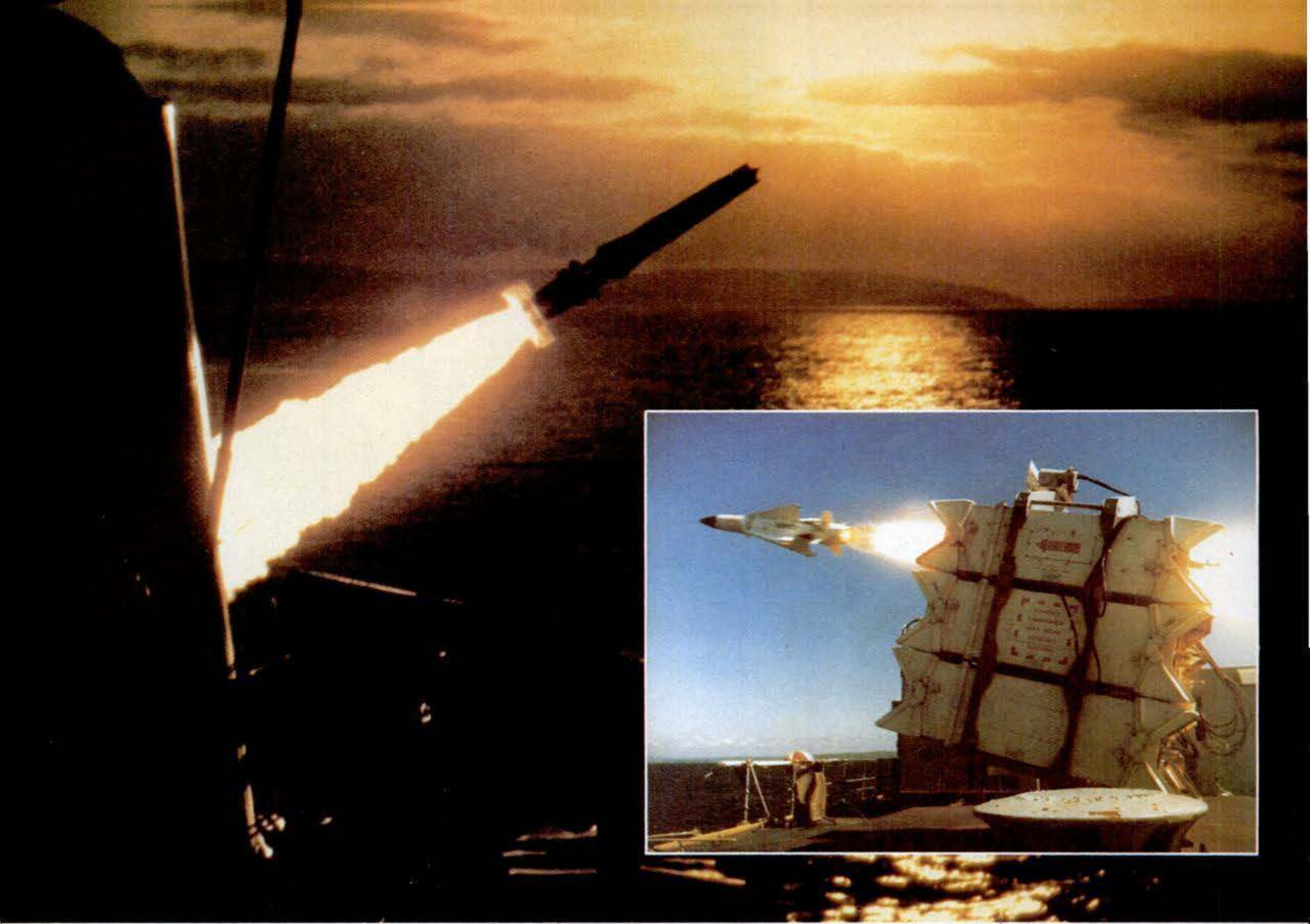

Seawolf, an antimissile system made by British Aerospace, is one of the few defenses that can detect and destroy low-flying missiles such as Exocet. But the ill-fated Sheffield carried the Sea Dart (inset) instead. Also made by British Aerospace, it was successful against Argentine aircraft but not against Exocet.

Heat-guided TOW antitank missile, made by Hughes Aircraft Co., reels out wires in flight to keep it in touch with a computer in the launcher. Range is 2.3 miles. An infrared sight lets it see through darkness, haze, and smoke.

Harpoon has five sections: The guidance section contains radar and inertial-guidance gear. The warhead is designed to penetrate the target before detonation. The sustainer section is the main propulsion system. Electromechanical actuators in the control section move control surfaces. Booster gives initial thrust.

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the ship was abandoned and sunk.

The sinking of the Sheffield was the most dramatic event in a few weeks of combat that showed just how modern warfare has been revolutionized by "smart missiles"—weapons that can change course to track down an enemy target relentlessly by using a host of electronically controlled sensing and guidance systems. In the Falklands, the Argentine navy suffered its greatest loss when a British submarine used Tigerfish torpedoes, guided by signals sent through wires that reeled out behind them, to sink the cruiser General Belgrano. When the British gained a beachhead on the Falklands, they used radar-guided Rapier missiles to fight off Argentine air attacks.

Military analysts were equally impressed with the role played by smart missiles in the Israeli invasion of Lebanon. Israeli aircraft used Shrike missiles that homed in on enemy radar beams to knock out the Syrians' surface-to-air missiles. They swept Syrian fighters from the sky with heat-guided Sidewinder missiles.

In little more than a month, the world had seen an impressive—appalling, to some—display of missile-guidance technologies. How do these smart missiles work? Though some specifics are classified, the general principles are available for the asking—a sure sign that weapons makers worldwide are working at the same level of technology. And the technology moves ahead inexorably as engineers try to turn this year's invulnerable weapon into next year's sitting duck. It's a battle of measure, countermeasure, and counter-counter measure that has been waged for more than a decade.

Smart missiles were causing a basic change in tactics at least as early as the 1970's, during the Vietnam War. U.S. jets suffered heavy losses from antiaircraft batteries as they tried to knock out key bridges with standard "iron bombs." Then came Pave Way laser-guided bombs. American jets centered a laser beam on the exact point they wanted to hit. A sensor in the nose of a 500- or 2,000-pound bomb picked up the reflected laser light, and steerable fins guided the bomb to within 25 feet of the target. "The accuracies made it possible to destroy in one or two sorties a bridge span that might otherwise have required dozens," said James Digby, an analyst at the Rand Corporation.

Although laser-guided smart missiles are still an essential part of the modern arsenal, they weren't much in evidence either in the Falklands or in Lebanon. The major targets in those two wars were ships and aircraft, which are best attacked by radar- and heat-guided missiles.

The Exocet, for example, found the Sheffield by radar guidance—first from the aircraft that launched it, then from its own on-board radar system. When the Exocet is fired, its on-board computer is given data about the target's range and bearing. It has an inertial-guidance system that uses a gyroscope and accelerometers to keep it on the proper course and a radar altimeter to hold it at the desired altitude above the surface—generally, just high enough so it doesn't smash into a wave. Data from the guidance system goes to the on-board computer, which steers the missile by controlling its movable tail fins. At about 10 miles from its target, Exocet turns on its own small radar set, finds the target, and locks onto it. Essentially the same kind of guidance system is used by the major U.S. antiship missile, the Harpoon.

The Exocet is smart, but it isn't brilliant. It worked against the Sheffield, but a second Exocet that was launched at the same time against another British vessel missed. It was decoyed by chaff—strips of metal foil that have been used since World War II to create confusing radar profiles. When the Argentines fired an Exocet in an apparent attempt to sink the aircraft carrier Hermes, they hit the Atlantic Conveyor, a container ship, instead.

Lessons from Lebanon

If the Exocet got mixed reviews for its performance in the Falklands, the U.S.-made Sidewinder missile got raves for what it did to Syrian Migs in Lebanon. The Sidewinder uses the latest guidance technology. The heart of the AIM-9L model used by Israel is a heat detector built around an indium antinomide alloy that is sensitive to specific wavelengths of infrared radiation. To be effective, the detector must be cooled to below minus 100 degrees C (−212 F). The AIM-9L uses a refrigerator that keeps the sensor cold by boiling away liquid hydrogen. Older models of the Sidewinder had to be fired from behind the target aircraft; they would literally fly up the tailpipe by detecting heat from the jet exhaust. The AIM-9L model can be fired head-on, because it can sense exhaust gases as they flare away from the tailpipe. (The sensor is so effective that it can detect heat from the friction of air molecules on a wing, engineers boast.) A proximity fuse sets the missile off when it nears the target.

But to understand the almost incredible Israeli air dominance—they shot down 79 Syrian aircraft without a loss—you have to examine the complex scheme of which Sidewinder was a part, analysts say. The critical element of the scheme was a slow-flying, prop-driven aircraft, Grumman's E-2C Hawkeye. The Israelis have four of them, all loaded with the most modern radar-detection and analysis equipment. The E-2C can track low-flying aircraft at a range of more than 200 miles using its sophisticated, computer-orchestrated radar system. It can also detect radar emissions from hundreds of airborne or ground-based sources in a 400-mile radius.

The first step toward Israel's victory in the air was to knock out Syria's SA-6 surface-to-air missiles. They used an ingenious method. First, they sent over unpiloted drones to attract the attention of the SA-6 batteries. They swiftly identified the radar frequencies that the Syrians used to track the drones. Radar homing systems on U.S.-made, air-launched Shrike missiles were set to those frequencies, and the Shrikes followed the radar beams to destroy the SA-6 batteries.

When Syrian Migs took off to challenge Israel's American-supplied F-15 and F-16 fighter jets that carried the Shrikes, they were tracked almost from the end of the runway by the E-2C's radar. The E-2C also pinpointed the frequencies that the enemy aircraft used to find their targets. Those frequencies were then jammed, blinding the enemy. Finally, the Israeli jets launched their Sidewinders, which were guided to the Migs by their IR sensors. "The Sidewinder was just part of the end game," says William B. Farnsworth of Raytheon, which makes the missile. "The real thing was the command and control aspects of the battle."

Antitank missiles

A different version of the story is being told on the ground, where the fight pits foot soldier against tank. Formerly, tanks held a clear edge. "Our object is for a very few men with very sophisticated weapons to take on a whole tank battalion and stop it," says William C. McCorkle of the Army Missile Laboratory at the Redstone Arsenal in Alabama.

Israeli tank losses in the 1973 war with Egypt made it appear that foot soldiers could fight tanks on better-than-equal terms. Scores of Israeli tanks were knocked out by wire-guided missiles fired by Egyptian infantry men. Correspondents remember battlefields littered with burned-out tanks and the leftover missile wires.

In Lebanon, though, Israel changed its tactics slightly. Instead of having tanks spearhead the attack, Israel is

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said to have sent in ground soldiers ahead of them. They cleared the battlefield of the Syrian troops who carried the antitank missiles. Then the tanks rolled forward.

Israeli tactics took advantage of the major weakness of smart antitank missiles. Unlike "fire and forget" missiles, such as Exocet, whose launch crew can be long gone when the missile hits home, today's antitank missile is effective only if someone has the target in his line of sight.

Many of the current generation of antitank missiles get their instructions over wires that reel out behind them. In the original versions, infantrymen used joy sticks to guide the projectile to the target. Newer versions, such as the U.S. Army's TOW and Dragon, have a guidance system that uses a heat source on the missile to keep it on course. The soldier who launches the missile keeps his sight cross hairs on the target. An infrared sensor in the launcher follows the heat source on the missile and thus knows if it wanders off course. Then computer-generated commands, which reach the missile through two wires that reel out behind it, fire side-thrusting rockets to put it back on track.

Newer antitank missiles, such as the air-launched Hellfire and the ground-launched Copperhead, use lasers to zero in on the target. A sensor in the head of the missile detects laser light reflected off the target.

The key, of course, is to keep the laser beam aimed at the target. One way to do that is to mount the laser on a helicopter. The army is also working on the Ground Laser Locator Designator, which foot soldiers could use. In the case of Hellfire, a helicopter could fly over the battlefield and launch the missile. Copperhead could be launched by a tank miles away from the target. The laser designator would be switched on at the last moment, giving the missiles the laser spot they need to hit home.

On the horizon is a new generation of wire-guided missiles using fiber optics. These missiles would reel out thin glass threads capable of carrying enormous volumes of data. A soldier could launch the missile at a target that is out of sight. As Hughes Aircraft, which is working on fiber-optic missiles, describes it: "Everything the missile 'sees' through the camera on its nose—tanks, troops, command posts—zips through the plastic-clad glass fiber to the launcher's display. The glass thread serves as a two-way street as the computer takes over, snapping steering commands back up to the missile, veering it to the selected target."

Along with this constant updating of attack missiles, there is constant work on missiles to destroy missiles or make them ineffective. For example, a helicopter that wants to launch Hellfire—or its enemy equivalent—puts itself in range of small and portable ground-to-air missiles. The British in the Falklands had Rapier, which uses a sophisticated radar guidance system, and the shoulder-held Blowpipe, guided by a joy stick. The U.S. Army has the radar-guided Roland and an infrared-guided antiaircraft missile, Stinger, that one soldier can fire.

Many analysts believe that if the Sheffield had been armed with the British-made Seawolf antimissile, the ship might have been saved. The Seawolf has radar designed to detect any incoming missile, even a sea-skimmer like Exocet, in time to shoot it down. Another antimissile weapon used on ships is the Phalanx, a modern version of the Gatling gun. Phalanx is a defense of last resort. Its multiple barrels throw up a wall of metal, firing 3,000 rounds of 20-millimeter ammunition a minute.

> "If the infrared Maverick works as planned, it will find its way in the dark and in any weather"

The ultimate question is whether defense measures can keep up with the steady improvement in attack missiles. The answer you get often depends on whether you ask the people who are working on defense or those working to make the attack more deadly. Designers at McDonnell Douglas, maker of the Harpoon, think they have a weapon that puts any defense to a hard test. The Harpoon's guidance systems are continuously being updated. For example, the first versions were programmed to pop up from the surface and dive into an enemy ship at the last moment for better hull penetration. The latest models stay at surface level "for better survivability," says Bruce Craddock of McDonnell Douglas. "It's so low that it's difficult for a radar to track."

Maverick, an air-to-surface missile made by Hughes Aircraft Co., is another example of a smart missile being made ever smarter. The original version, now in use by the Air Force, is guided by television. A TV camera in the nose of the missile produces a picture on a television screen in the cockpit of the aircraft. The pilot picks out the target, centers cross hairs on it, and launches the Maverick. Its microprocessor guides the missile to the spot by moving the missile's fins.

The limitation of the TV-guided Maverick is that it can be used only in daylight and in clear weather. A new version under development uses an imaging infrared detector, which produces images on a display screen. The pilot picks out a target, such as a tank, by looking for its distinctive heat signature. An on-board microprocessor guides the missile to it.

If the infrared Maverick works as planned—there are Congressional critics who say it won't—it will find its way in the dark and in any weather. Robert Knowles, technical manager for Maverick, remembers one nighttime test. "We made a launch near midnight," recalls Knowles. "I was watching the missile broadcast imagery to the ground all night. When I drove out on the range in the dark, I drove past the target tank several times before I saw it. Can you imagine what it would be like to be a tank commander and know you could be hit by a missile fired by an aircraft several miles away when you can hardly see the ground in front of you?"

The round of measure, update, and countermeasure goes on. To give another example, Aerospatiale, the French company that builds the Exocet, is working simultaneously on the next generation of Exocet and, in collaboration with a second company, on a weapon to counter the Exocet. The counter-weapon would be launched vertically, lock on the missile, then whip across the water to destroy it.

And, of course, for every countermeasure there is a counter-countermeasure. The military and its suppliers won't talk about details of the technology, but they sometimes describe their results. Craddock, for example, says that the Harpoon has been flown "against all types of countermeasures, and the success rate is 90 percent."

Meanwhile, the marketing of smart missiles has added an unsettling element to international relations. Industry sources say that more than 20 nations have bought Exocet, for example. Marketing tactics can be amazingly similar to those used for more innocuous machines. If you buy this year's model of the Harpoon, for instance, you get a 36-month warranty, up from 24 months for the older model. A purchaser can also get a service contract, exactly like the one you can buy for your refrigerator. The difference is that this appliance sinks ships and kills people. PS

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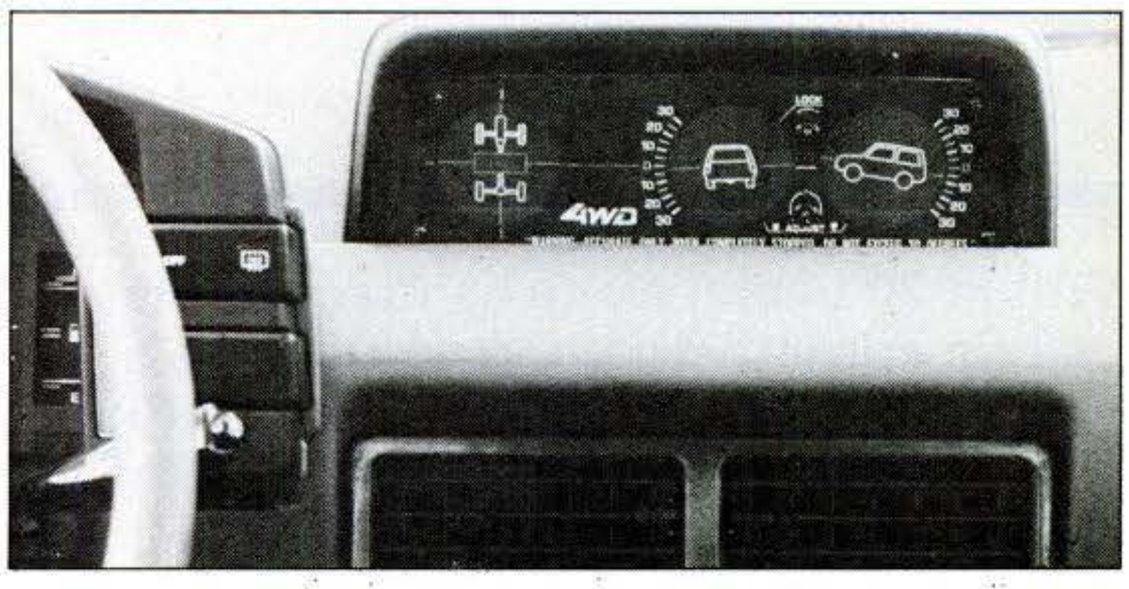
Toyota Tercel 4WD wagon

"It's an odd-looking thing, like something you might get on a blind date."

With that introduction, Toyota's senior vice-president Norm Lean pulled the wraps off the Japanese auto maker's surprise new vehicle for the U.S. market—a four-wheel-drive family wagon that will carry the Tercel name.

The wagon is a departure for Toyota, both in styling and concept. It's long (170 inches) and boxy (59 inches tall), has unusual comfort for a 4WD, and will carry plenty of gear for a camping or skiing trip. It is also intended as a general-purpose vehicle for around-town driving. It is *not* intended for hard off-road excursions.

The six-speed manual transmission has no transfer case and can be switched from two-wheel to four-wheel drive any time. The transmission incorporates a very-low-drive-ratio (4.714:1) first gear. Says Lean: "It's a nice crawly gear for super-tough going in four-wheel drive."



4WD Wagon is equally at home on streets or slopes. A dash-mounted inclinometer (right) shows the car's angles of pitch and roll. Clearly printed on the face of the instrument: DO NOT EXCEED 30 DEGREES.

Standard features include a new sealed ignition system with the coil integrated into the distributor, and radial tires that are both mud and snow rated. Ground clearance is a high 7.5 inches. Sticker price of the top-of-the-line Tercel 4WD is expected to be about $9,000.—*Jim Schefter*

Turbocharged samurai

Imagine a 2+2 sports car with sleek lines, crisp handling, and quick power. Imagine 21 mpg in town with a turbocharged engine. Imagine Starion.

That's Mitsubishi's entry in the growing galaxy of Japanese-built sports cars and the company's attention grabber for its U.S. debut. For several years Mitsubishi-Chrysler's Colt/Champs, Challenger/Sapporos, and Ram 50/Arrow compact pickups have been sold by Chrysler dealers. By the time you read this, Mitsubishi will have its own U.S. dealer network selling a three-car line: a two-door hatchback called Cordia, the four-door Tradia, and the Starion.

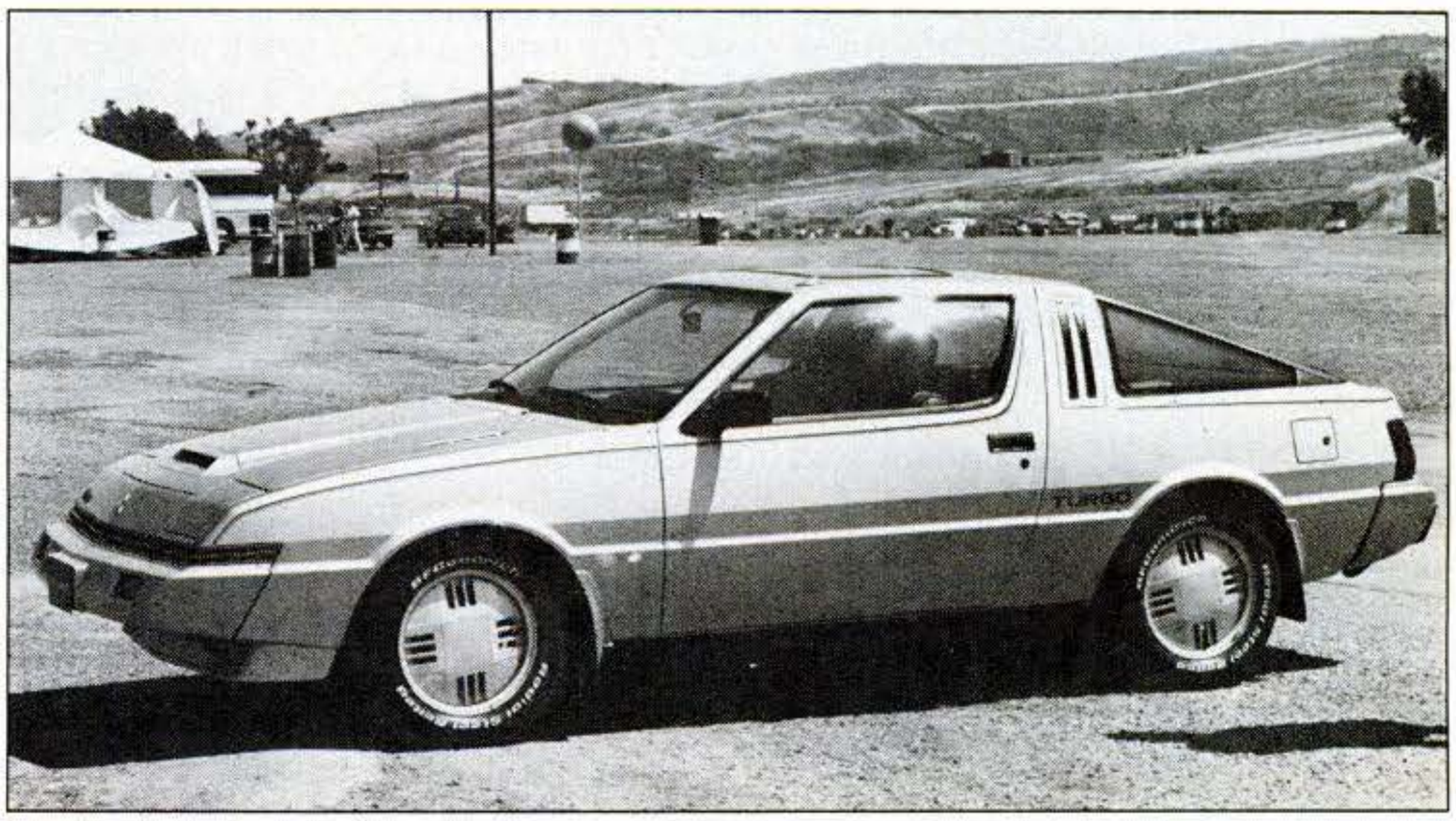
Starion pre-production models made available to PS for informal test runs around two California tracks easily justified Mitsubishi's performance claims. In comfort, the sharply contoured front buckets actually felt too firm, but elbow, leg, and head room were ample. The tight rear seat was typical for a 2+2, and the baggage compartment was unusually shallow.

Starion packs high-tech muscle with a 2.6-liter four-cylinder turbo, the largest in its class, developing 145 hp and 185 ft.-lbs. of torque. Its curb weight is just under 2,900 pounds, and the wheelbase is 95.9 inches. The car's handling and responsiveness are excellent.

A five-speed transmission, independent rear suspension, and power-assisted recirculating-ball steering combined to give me a feeling of complete road control. The car held the tightest corners at high speeds with little body roll. Acceleration was quick through the entire gear range, with no lag or flat spots.

The designers gave the Starion a boxy wedge shape, with concealed headlights, a front air dam, duck-tail rear end, and other features to reduce aerodynamic resistance; C_d is 0.35.

Standard equipment includes power windows, intermittent wipers, AM/FM four-speaker stereo, electronic fuel injection, power-assisted steering, four-wheel ventilated disc brakes, and 14-inch cast-alloy wheels. Price? About $16,000.—*J. S.*



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Safer skies into the 21st century: FAA's revolutionary control system

Within 20 years, twice as many planes will be crisscrossing our skies. Here's how the FAA plans to direct the traffic

By JIM SCHEFTER
PAINTING BY RAY PIOCH

The room is a cavern, dimly lit and hushed, its long aisles flanked by scores of glowing scopes. At each, one or more persons relay instructions to pilots through their headset microphones, all the while shifting paper data strips and scanning the lighted blips and data blocks moving across green-screen displays.

In another area, a single operator works at a horseshoe-shaped console, watching the three large cathode-ray-tube (CRT) display screens that form the open U. Additional small CRT displays and keyboards keep the operator in touch with pilots, a complex computer system, and other controllers.

The first room is familiar, one of the Federal Aviation Administration's 25 air-route traffic-control centers. It's also obsolete, destined for oblivion as a new generation of computers and consoles, similar to the single-operator prototype console, comes into use. Called "sector suites," because each will be able to handle multiple geographic sectors of airspace, such consoles will be highly computerized themselves. At the same time, a host of new cockpit electronics is on the way.

The coming system, devised by the FAA, puts more authority in the cockpit, improves control operations on the ground, expands capacity, and increases safety. It allows more direct routing and more efficient landings, and thus saves time and fuel. The differences between old and new are astounding.

The small CRT between the two pilots blinks momentarily as the captain types in, "Flight 111," and presses the ENTER key. A message scrolls onto the screen:

FLIGHT 111 IS CLEARED LOS ANGELES TO THE DENVER TERMINAL AREA. FLIGHT-PLAN ROUTE APPROVED. ALTITUDE REQUESTED UNAVAILABLE DUE TO REPORTED TURBULENCE AND POSSIBLE THUNDERSTORMS. EXPECT CLEARANCE TO FLIGHT LEVEL 330 AND POSSIBLE CHANGE EN ROUTE. DEPARTURE SLOT 1720Z. CONTACT GROUND CONTROL WHEN READY. CONFIRM.

The captain pushes the CONFIRM key, sees the flashing C in the corner of the screen turn bright and steady, then presses another key marked PRINT. Seconds later, a strip of paper containing the full message rolls silently from a slot.

At the air-traffic-control center miles away, the controller receives confirmation that Flight 111 has its clearance and instructions.

"For the first time, we've laid out what we want to do for the next 20 years," says Gerald L. Thompson, director of the FAA's Airway Facilities Service. "We've been working with a great mix of old technologies that is expensive to maintain or modify. Just to stay even, we've got to do something."

What they did was put together a National Airspace System Plan that blends new technologies to meet most of the competing demands from those who fly.

"The result is a package," Thompson says. "It doesn't come apart easily." It includes:

- New computers to replace today's hopelessly overloaded vintage machines. Even some minicomputers now have more processing power than the aged giants used in FAA centers.
- A communications system called Mode S (for selective address) that makes each aircraft as individual as your private telephone. Many messages will be transmitted by computers to cockpit printers or CRT displays, eliminating the human voice.
- Control-center automation to give controllers more flexibility, expand their coverage area, and shift more of their workload to computers.
- Automated weather-advisory services. Pilots on the ground will use telephone key pads to get automatically updated weather reports and forecasts over the phone from a voice-response computer. Airborne pilots will get the same service through their Mode S equipment.
- A new microwave landing system that will make bad-weather landings easier, safer, and more efficient.
- Airborne collision-avoidance gear to warn pilots when other aircraft are nearby.
- New communications links using microwave and satellite systems. Computers nationwide will be tied together; radar will feed more effectively to operations centers; controllers will have quicker access to each other.

As Flight 111 climbs out of Los Angeles International Airport and begins a sweeping turn over the ocean, a bright blip appears on the controller's sector-

Continued

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Tomorrow's air-traffic controllers will use sector suites similar to the above (developed by Mitre Corp.). Center CRT shows traffic in sector; right CRT displays flight data for each craft; left one shows one plane's flight profile. Small displays permit touch-entry communication with computer—and cockpit. Sector suites will replace radar scopes (below) now in control centers, such as this terminal-area facility on New York's Long Island.

PHOTOS: ABOVE, JOEL FREID; BELOW, COURTESY SPERRY UNIVAC.

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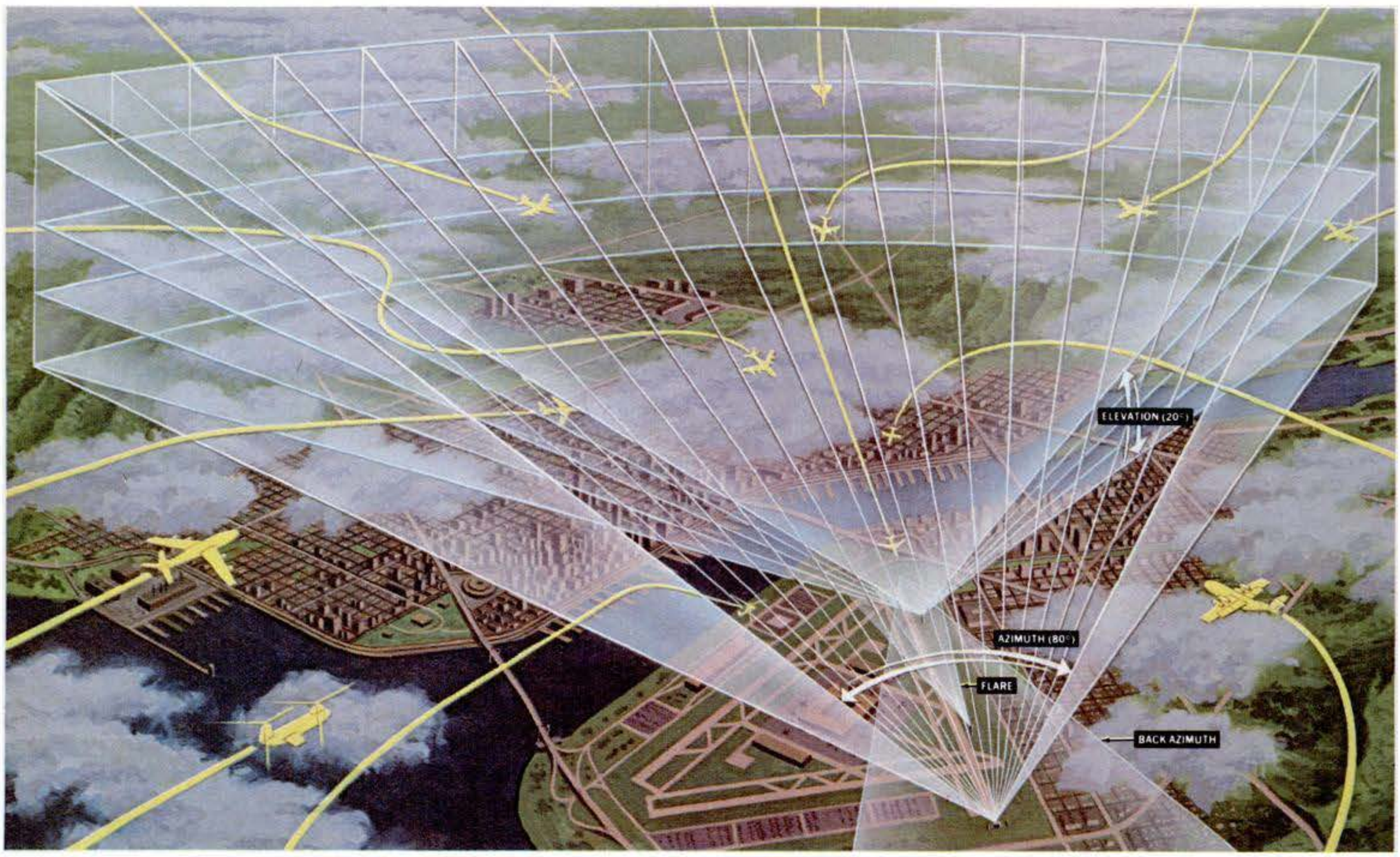

Microwave landing system, one part of the new FAA plan, lets different aircraft approach the runway at different speeds and angles. Azimuth antenna tells pilot his position left or right of intended approach path; elevation antenna gives vertical position; flare antenna takes over near touchdown. Back-azimuth antenna guides pilot away in an aborted landing.

suite display. A small data block containing basic information on the flight moves with the blip. The controller could get more—everything from number of passengers to fuel consumption for that plane—by displaying 111's full computer file on a CRT.

Processors in the console receive a steady flow of tracking updates from the large computer. Simultaneously analyzing the direction, speed, and altitude of each plane in the sector, the system moves 111's blip across the display. If the plane deviates from its flight plan or is threatened by air traffic, a warning alarm alerts the controller.

As 111 nears the edge of the sector, another warning flashes. At the same time, the computer notifies the next sector suite that Flight 111 is about to enter its airspace. The new controller touches a key to accept it. In moments, 111's radar blip and data block disappear from the departure sector. The computers have automatically transferred the flight.

Controllers are eager for the new system. "It will definitely increase our ability to handle aircraft," says Los Angeles tower chief Ivan Hunt. "And it will reduce the stress on all of us."

With Congressional approval and adequate funding (nearly $9 billion over 10 years and $725 million for 1983), FAA Administrator Lynn Helms expects elements of the new system to begin appearing rapidly. The FAA hopes to select a computer within two years from competing designs from IBM, Amdahl, Sperry Univac, and perhaps others.

The first of these new "host" computers, so designated because they must initially use today's software, could be on line by 1986, beginning the phase-out of the obsolete IBM 9020 main-frame machines. "We've used up the capability of the 9020's," Helms told a House subcommittee several months ago. "We've been upgrading the software to get by, but we can't do that anymore."

The 9020's are so old that spare parts are becoming rare. When they fail—as they increasingly do—even backup computers can't prevent delays and disruptions on the airways. When they work—which is still most of the time—the computers sort out radar data, route it to display scopes, maintain limited information on flights, watch for conflicts in the air, and do considerably more. But they don't dispense weather reports, provide overall analysis of traffic flow, juggle radio-frequency assignments, or communicate directly to cockpits. Much of the workload falls to controllers, who must absorb a mass of information, stay alert, and handle air-ground communications.

Helms insists that the new computers be commercial machines not specially designed for the FAA. He expects them to have at least 10 times the capacity of the 9020's. Redundant systems should guarantee that the air-traffic-control system isn't affected if a prime computer fails. The computers will also begin handling both en route and terminal (landing and takeoff) operations—duties separated under the current system.

Within a control center, the changes will be massive. Sector-suite consoles will replace the long lines of radar scopes. Detailed design and specifications for the suites are being completed now. Each will be fed by two computers and have three large displays. Each display will have its own processor and be capable of handling any type of control operation—en route, terminal-area, or tower—though no single controller will simultaneously handle all three.

A controller at a sector suite will have a situation display (real-time radar data), a strip display (information on aircraft being controlled), and a planning display, the FAA's Thompson says. The latter two eliminate the paper strips of aircraft data and let the controller call up weather information, project traffic flow, and generally use the computer to track operations.

The new system should dramatically reduce operating

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and maintenance cost. It will reduce the number of air-traffic-control personnel needed by about 2,500 over the next decade. "I don't see machines replacing controllers any time soon," Thompson says, "but sector suites will make their job more productive."

The captain of Flight 111 doesn't like the looks of the thunderheads standing like black columns in the distance. He types a few quick instructions into his keyboard, then watches his CRT.

THUNDERSTORMS AND SEVERE TURBULENCE, WITH TOPS ABOVE 50,000 FEET, NOW REPORTED ALONG A NORTH-SOUTH LINE 80 MILES LONG . . .

The flight is headed directly toward the storms. Picking up his microphone, the captain radios his controller: ". . . we've got some real thunder-bumpers ahead. Request deviation to the north."

"Roger, 111," the controller responds. "Understand you have weather and request deviation. Expect new clearance on Mode S. Stand by."

The controller keys in instructions and watches as the computer analyzes the impact of Flight 111's request. In moments, the computer gives the all-clear and recommends a new heading. The controller toggles his mike: "Flight 111, turn left to heading zero-three-zero. Monitor Mode S."

Even as the plane begins to turn, the controller types in new instructions, based on data provided by the computer: how far to go, when to turn again, what new course to take for Denver. At the same time, the computer calculates a new arrival time and adjusts the planning for descent and landing. Before 111 completes the turn, the data appear on the cockpit CRT.

"Now everything between controllers and pilots is done verbally," says Jerry Walton, director of the Los Angeles air-route traffic-control center. "Vector headings, traffic information, weather, delays, clearances, everything." The new computers and Mode S gear will change that.

By 1990, aircraft flying above 12,500 feet (almost every commercial flight and many private flights) will be required to replace current transponders with Mode S gear. (Transponders receive an "interrogation" signal from ground radar and respond with an answer that includes an assigned four-digit number. Many transponders also report the altitude of the aircraft. The answer appears on controllers' radar scopes. Interrogation signals are not selective; they trigger responses from every transponder within range.)

With Mode S, each aircraft will have its own unique channel. Controllers will transmit instructions to individual aircraft simply by keying them into the computer. A variety of cockpit gear to receive the messages is expected from the avionics industry. Each airline or aircraft owner will select the display format desired. The data link won't eliminate conversation between controllers and pilots, but it will reduce it to the essential minimum.

General-aviation aircraft won't be required to have Mode S transponders as long as they stay below the 12,500-foot ceiling. "But we want to put enough services on the data link to entice them to install it," Thompson says.

So far, avionics manufacturers are moving slowly on Mode S hardware. Automated weather-reporting hardware already is available, and the FAA intends to expand all elements of the system with improved versions—including visibility sensors and laser-type cloud-height sensors to report ceilings as high as 3,000 to 5,000 feet. Weather monitors are to be installed at airports and other locations throughout the country. They will report automatically to central locations. From there, weather information will be computer-processed and disseminated. By 1990 the system will include continuous regional summaries broadcast by computer over very-high-frequency (VHF) navigational radios, with a complete cycle every few minutes.

Alarm!

The insistent sound and flashing arrow trigger instant action by the captain of Flight 111. An arrow on a brightly lighted display points down. The captain puts the airliner into an immediate descent. Seconds later, a military jet passes just a half-mile above. Back in the cabin a few drinks are spilled, a small price for avoiding a midair collision.

A key part of the FAA plan is the long-awaited Threat-Collision Avoidance System (TCAS) to be installed in aircraft cockpits [PS, Sept. '79]. After years of development and considerable controversy over competing concepts, Administrator Helms selected a system in 1981. Two versions are planned, one for general aviation and one for commercial aircraft. Neither system will be mandatory, but the FAA expects them to be widely used.

The commercial unit includes a transmitter, a receiver, and a microprocessor-based computer. It analyzes responses triggered from other aircraft transponders to determine if a collision is likely. (It will not locate aircraft without transponders.)

If the answer is yes, the computer calculates the best evasive maneuver, triggers a cockpit warning, and tells the pilot whether to go up or down to avoid the collision. An advanced version now in development will provide left-right evasive maneuvers, as well.

The general-aviation system is far less sophisticated. It will warn pilots only that a transponder-equipped aircraft is nearby. It will be up to the pilot to figure out what to do. But its cost should be no more than $2,500, compared with about $40,000 for the basic commercial-aircraft unit.

"General aviation has about 20 midair collisions a year, half of them in the airport-traffic pattern," says Clyde Miller, TCAS program manager. "At least this system might let them know that another plane is there."

In Flight 111's cockpit, the informative little CRT flashes with a new message: CLEARANCE TO BEGIN DESCENT INTO DENVER. *The message includes full information about weather, choice of approach path, runway and gate assignment, and even a new estimate of landing time.*

The pilot swings the plane in a wide arc toward the assigned runway, descending rapidly. Soon he greases it in for a gentle landing. Despite weather problems and consequent rerouting, Flight 111 arrives in Denver just five minutes late.

To improve both safety and efficiency in airport operations, the FAA is pushing ahead with microwave landing systems (MLS) to replace the current VHF-based instrument landing system [PS, May '79]. Both systems transmit signals to cockpit instruments that allow pilots to descend along a glide path and land in poor visibility.

The MLS system, developed at the FAA's Technical Center in Atlantic City Airport, N.J., and similar to the one used by the space shuttle, is far more accurate: altitude errors as little as two feet and horizontal errors of 13 feet or less when an aircraft crosses the runway threshold. It will permit landings with much less visibility than currently required, and with lower ceilings.

But the major advantage of MLS is the broad funnel-shaped signal it sends out. Instead of locking onto a narrow beam miles from the runway, pilots can fly approaches from a wide fan of angles. They can also come in more steeply. Thus controllers will be able to get planes on the ground more quickly. MLS also could guide aircraft through automatic landings.

"It all backs up at the airport," Ivan Hunt said in the Los Angeles tower. "Now we're going to change that." PS

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Never miss a call:
PS buyer's guide to

cordless phones

Range: up to 700 feet. And some work both as extensions and intercoms

By GORDON McCOMB
PHOTOS BY GREG SHARKO

You're out back by the pool taking life easy, sipping a tall, cold drink. Suddenly, you hear a faint sound—the phone! Now comes the frantic dash to get inside before it stops. You rush, spilling the drink and soaking the carpet with your wet feet. You snap up the receiver—"Hello!" But the only response is a frustrating buzz.

Cordless phones can solve the problem. Because the phone literally goes where you go, you never again have to miss a call.

Cordless phones work through your phone line as a standard extension—you still pay for your calls. A base station (which also doubles as a recharger for the phone's battery) plugs into a standard extension-phone jack in your home. (If you don't have one, you must have it installed.) The base station contains a transmitter and a receiver—it relays calls to the wireless handset you take with you.

But a cordless phone isn't just a phone without strings attached. Many models now have features that make them even more attractive and useful than a conventional phone. I took a close look at more than three dozen of the top-selling wireless phones and found a great variety of styles, features, and prices.

Similarities and differences

Cordless phones have a lot in common. Most of them work the same way. They all have rechargeable nickel-cadmium batteries, and almost all automatically redial the last number called when you get a constant busy signal. They have Touch-Tone-type key pads for dialing and price tags of under $400.

Most of the cordless phones convert the buttons you push into the "clicks" used by a pulse-dialing system. (Pulse dialing works on any telephone-company line, whether you have the older rotary dialer or Touch-Tone keys on your phone.) But the Pathcom Pacer 9800, Muraphone 800/801, and Electra Freedom Phone FF-4000 can also operate in Touch-Tone mode for quicker dialing. (If your phone line accepts pulse dialing only, the Touch-Tone mode will not work.) Incidentally, these cordless phones are the most expensive on the market—all of them are in the $350 to $400 range.

What are the differences among cordless phones? Styling, for one thing. Some units are shaped like walkie-talkies. They're great for hanging on your belt, but they're not always the most comfortable or easiest to use. Most cordless units have contemporary Trimline-type styling, which better fits the decor of the typical home or office, as well as the shape of a person's face.

The effective range of a cordless unit is an important consideration. The Federal Communications Commission limits frequency range and power output, so most units have a range no greater than about 700 feet. But some models—such as the Universal Talk-A-Bout, Radio Shack ET-360, and Webcor 777—don't have an external antenna and are designed for short-range use (about 100 feet). These are fine for apartments or areas where you won't be far away from the base station.

It is possible (though not likely) that someone else in your neighborhood could have a cordless phone that works on the same frequency as yours. To prevent the unauthorized use of your phone line by another cordless-phone owner, many cordless phones disable the dial-out capability when placed in the base. Two phones, the Electra FF-4000 and Mura 800/801, use security codes so only you can use the phone. Additionally, most manufacturers use up to five or six different frequency sets for their units, so the chances of your phone working on the same frequency as your neighbor's are really quite slim.

Not all cordless phones can originate calls. The Cobra 15S, Radio Shack ET-310, and Webcor 525, for example, lack a dial. They're also the least expensive.

Exceptions

Almost all cordless phones have a convenient CALL button on the base unit that can be used to page the remote. If you're working outside and someone inside answers a call for you, they can alert you by simply pushing the CALL button. When you hear the page tone you answer by activating the remote.

A few models also allow the remote to call the base unit. Two-way paging is available on the PC-1800 from ITT; Mura 800/801; Pathcom 9800; Cobra models CP210S, 120S, and 140S; Uniden Extend-A-Phone EX-1500, 4000, and 5000; and Webcor 576 and 575.

Each of these phones has an intercom that operates separately from the phone line. But incoming calls still come through, so there's no chance of missing a call while in the intercom mode.

Of the two-way-paging phones, the ITT PC-1800, Mura 800/801, Cobra CP120S and 140S, and Webcor 576 have a call-on-hold provision. You can answer a call from the base station, put it on hold, page the remote, and then put the call through.

Three of the cordless phones I examined have extended-range capabilities. Although they don't have a higher power output than the others, their makers claim that certain proprietary manufacturing techniques enable their remotes to operate at up to 1,000 feet from the base. These phones include the Pathcom 9800 and 8800 and the Electra FF-4000. The FF-4000 operates in a unique 49-MHz/49-MHz "multiplex" (transmit and receive on the same frequency) mode, and avoids the range limitations of the usual 1.7-MHz frequency.

In all cases, the actual maximum range attainable is dependent on many conditions (which I'll get into later). So use the ranges claimed by the manufacturer only as a guide.

Even though cordless phones have auto-redial circuitry built into them, a few models—Electra FF-4000, Cobra CP120S and 140S, Radio Shack ET-330, and Mura 800/801—have multi-number memories. The Radio Shack unit can store two numbers; the Electra, three. Both Cobra models can memorize up to nine frequently used numbers, but the Mura holds the record at 32. In many cases, a separate battery is used to prevent accidental erasure of the numbers during a power failure.

Some recently introduced models are considerably smaller than their predecessors. Electra's FF-3500 and Cobra's 110S, 120S, and 140S are miniaturized—yet they still come with the full range of features. Electra's FF-3500 is truly pocket-sized, while the Cobra models are about one-third the size of a standard phone.

Cordless phones even come in speaker-phone versions. If you need to do hands-free talking, consider Uniden's EX-4000 and EX-5000.

Installation hints

Now that you've got your cordless phone and have unpacked it from its box, what do you do? The base station easily connects to any grounded AC receptacle as well as to the standard modular telephone jack. For best

Continued

Enjoy the pool without scrambling indoors for a ringing phone. Clockwise from left corner: Radio Shack ET-310, Webcor 575, Cobra CP205S, Freedom Phone FF-4000, Muraphone 600, Freedom Phone FF-3500, Uniden Extend-A-Phone 3000, Pathcom Pacer 9800 (center).

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Buyer's guide to cordless phones

Brand	Model	List price ($)	Range (ft.)	Secure	Intercom	Wall install	Access jack	Remote charge	Call on hold	Two-way page	Multi-dial memory	Speaker	Concealed antenna	Touch-Tone option	Styling*	Mini or standard size	Comments
Cobra	CP15S	89.95	n.a.											n.a.	D	Std.	Answer only, no auto-redial
	CP100S	159.95	600				●	●							W	Std.	
	CP200S	159.95	600			●	●	●							D	Std.	
	CP205S	169.95	600			●	●	●							D	Std.	
	CP210S	199.95	600		●	●	●	●		●					D	Std.	
	CP110S	199.95	600			●	●	●							D	Mini	
	CP120S	219.95	600		●	●	●	●	●	●	●				D	Mini	Nine-number memory
	CP140S	249.95	600		●	●	●	●	●	●	●				D	Mini	Nine-number memory, two-phone set
Electra	FF-4000	349.95	1,000	●			●				●			●	D	Std.	Coded security system, three-number memory
	FF-3500	329.95	600	●											W	Mini	
	FF-1550	279.95	600	●	●		●	●							D	Std.	
	FF-550	219.95	600	●				●							D	Std.	
	FF-3050	239.95	600	●											W	Std.	"Military" style
ITT	PC-1800	299.95	n.a.	●	●		●	●	●	●					D	Std.	
Mura	510/511	150.00	150			●		●							D	Std.	
	600/601	200.00	600	●		●	●	●							D	Std.	Comes with separate charger
	800/801	n.a.	600	●	●	●	●	●	●	●	●			●	D	Std.	32-number memory, coded security system
Pathcom	8800	349.95	1,000	●		●	●	●						●	D	Std.	
	9800	399.95	1,000	●	●	●	●	●		●				●	D	Std.	"Hook flasher" button
Radio Shack	ET-330	199.95	500		●		●				●				W	Std.	Two-number memory
	ET-310	119.95	600				●							n.a.	W	Std.	Answer only, no auto-redial
	ET-360	99.95	50			●							●		D	Std.	Dialer in base
	ET-320	139.95	50			●							●		D	Std.	Dialer in remote
Uniden	EX-1000	129.95	50			●	●						●		D	Std.	
	EX-1100	149.95	50	●		●	●	●					●		D	Std.	
	EX-1500	219.95	700	●	●	●	●	●		●					W	Std.	
	EX-3000	189.95	700	●		●	●	●							D	Std.	
	EX-4000	229.95	700	●	●	●	●	●		●		●			D	Std.	
	EX-5000	299.95	700	●	●	●	●	●		●		●			D	Std.	Variable volume control
Universal	Tel-3300	199.95	700				●								W	Std.	
	Talk-A-Bout	129.95	100			●							●		D	Std.	
Webcor	576	n.a.	700	●	●	●	●	●	●	●					D	Std.	
	575	239.95	700	●	●	●	●	●		●					D	Std.	
	555	229.95	400				●								W	Std.	
	525	129.95	500				●							n.a.	D	Std.	Answer only, no auto-redial
	777	129.95	100	●		●							●		D	Std.	

*D: decorator styling; W: walkie-talkie type

reception, however, place the base unit as high up as possible. If you have a single-story house, there's not much involved—just about any table top should do. But in a two-story house, a room on the top floor will work best.

All base stations use the AC wiring in your house as a transmitting antenna. So the type and layout of your electrical wiring will have a great impact on the range of your unit. If your wiring is enclosed in metal conduit, the maximum range of your phone may be cut by as much as 50 percent. In that case, try this: Stretch a 25-foot extension cord out along a wall or two and plug the base into it. The extension cord should act as a fairly efficient antenna. In any case, keep the cord out of the way and never run it under a carpet where people might walk.

Fluorescent lights, motors, shavers, vacuum cleaners, and old or faulty dimmer switches can cause annoying snaps, crackles, and pops in your phone reception. Adding a suitable filter (available at Radio Shack and other electronics stores) on the AC cord of the offending device or the phone base station can sometimes improve matters. In a few cases, the interference can't be eliminated by a filter. If the trouble is caused by a faulty dimmer or motor, have it fixed. Fortunately, such interference problems are rare.

Other interference can come from someone using a nearby communications device that operates at or near the frequency of your cordless phone (even some radio-controlled model airplanes can cause trouble). If you suspect this kind of interference, try a phone that works at another frequency. This problem, too, is rare.

Before you connect a cordless phone, call your local phone company and tell them you are connecting an FCC-approved cordless phone to your line. Give them the brand name, model number, FCC registration number, and Ringer Equivalence Number. This information is always stamped on the phone itself or printed on the box or instruction manual.

Some other rules must be followed. Cordless phones can't be connected to pay phones or party lines. If the telephone wiring in your home will not accept the modular plug on the phone, you may need to have the proper jack installed (you can often do this yourself). Finally, the FCC will not allow you to fix a damaged or inoperative cordless phone. Repairs must be made by authorized technicians. PS

Choosing by size: Most cordless phones are Trimline types like the Uniden at left in photo. For pocketable portability you can choose Electra's FF-3500 at right.

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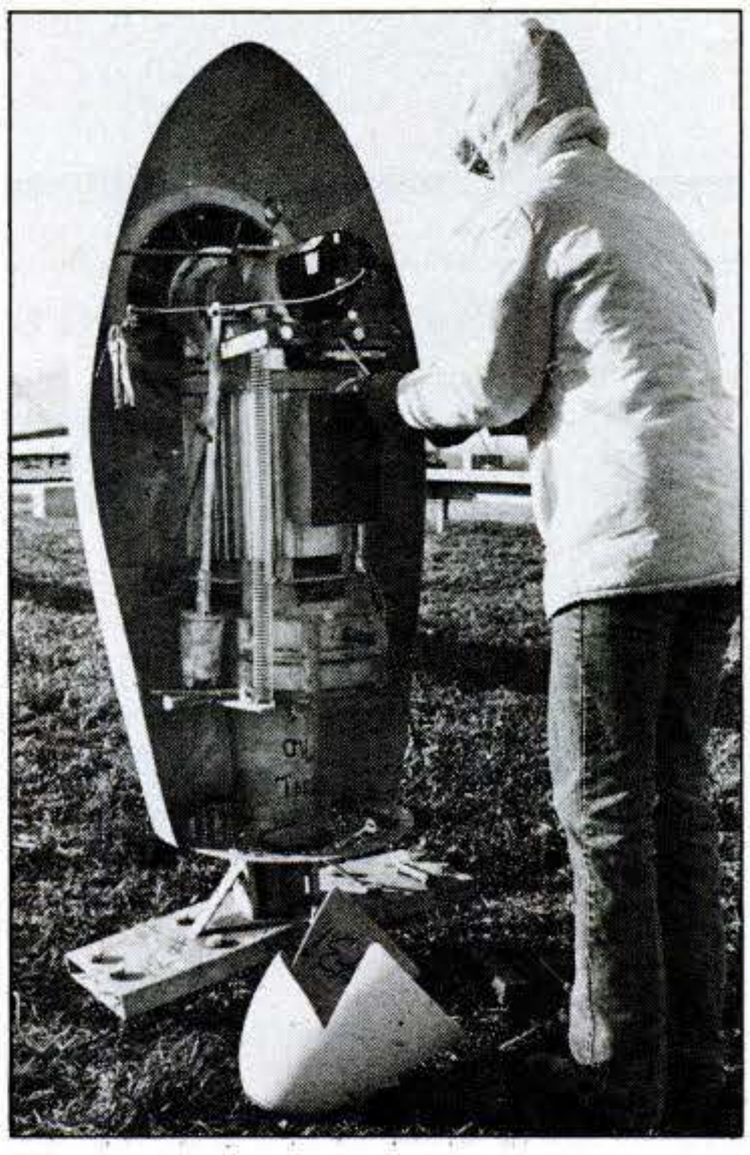
Mid-size wind generator

—simple, rugged, efficient

Graceful fiberglass rotor and clean lines of the 60-foot steel mast give this wind turbine a pleasing look. Double-reduction gear drive connects rotor to generator. Induction generator produces single- or three-phase 220-V or 440-V AC.



Mirror being mounted on pod by company technician Melanie Chisolm will allow a visual check of a bubble level (above her left hand) from the ground after the tower is raised. Guy wires will be adjusted until the tower is perfectly vertical.

In a good wind site, it could power a ranch or a couple of houses

By E. F. LINDSLEY

Last fall, in an appropriate but nippy wind, I stood on a hilltop near Ripon, Wis., and watched a team of Texans install a wind generator for the Wisconsin Power and Light Co. The team was from Jay Carter Enterprises, Inc.—the same Jay Carter who came up with the successful steam car I reported on in October 1974.

The wind turbine was a 25-kW experimental system, and everything about it—from the elegantly shaped blades designed to live through 100-mph winds, ice, and hail, to the heavy-duty induction generator—promised efficiency and reliability. Knowing Carter's track record for practical engineering, I was not at all surprised.

The wind generator is a horizontal-axis downwind type (the blades are downwind of the pod), so no tail vane is needed to steer it into the wind [PS, July]. The blades, 32 feet long tip to tip, are made primarily of fiberglass, a construction technique well known to Jay Carter and his son Jay Carter Jr. Using the inherent strength and flexibility of the fiberglass and some clever engineering, the Carters have come up with a blade design that needs no complex blade-angle control or feathering mechanisms to provide protection from high winds and other hazards. As wind speed increases, the blades adjust to regulate rotor speed. The inboard section of the inner blade spar is designed to twist and bend. This lets the blades form a shallow cone longitudinally and thus spill the wind. In extreme conditions they can bend as much as 45 degrees.

At the same time, as wind and rotor speeds increase, the blades start to feather. The weight distribution in the blade cuff (the flared inboard section) will exert enough centrifugal force to twist the blades to induce a stall.

If an overspeed of more than 30 percent (and consequent stall) occurs because of a loss of electrical load, a dashpot (a hydraulic damping control) will hold the blades at the stalled angle for 25 to 40 minutes, then allow them to revert to the operating position automatically. If all is well, the generator will then come back on line. If not, the blades are again locked in the stalled mode. If the blades get out of balance (for example, if ice should collect on them unequally), a blade brake will be automatically applied.

Carter's generator is tied into the utility power lines via an induction generator. One advantage of this is that the line automatically provides excitation and frequency control. Another advantage: You don't need batteries or other storage devices. Should demand for power exceed what's available from the turbine, additional power is drawn from the line. Conversely, if the wind generator produces more power than you need, it feeds back into the line and reverses the meter or records the amount fed back on a separate meter.

The 25-kW rated output assumes a 26-mph wind. "In a good wind site, such as north-central Texas, it would produce an average annual output of about 40,000 kWh," Carter says. "To put that in perspective, an average 2,000-square-foot, all-electric house in that area uses about 26,000 kWh annually," he adds.

Although Carter expects his turbine to run for at least 20 years and some parts for 30 or 40, he wants customers to be able to perform the minimal lubrication and inspection chores simply and safely—on the ground. For that reason, once the tower has been erected and leveled properly (see caption), one person with a winch or pickup can raise and lower it in minutes. Current price for the 25-kW unit is $25,000 installed (the only way Carter sells it). Delivery is on a mileage basis (from Jay Carter Enterprises, Inc., Box 684, Burkburnett, Tex. 76354). But generators on order now cannot be delivered until mid-1984 because of a backlog of more than 650 orders. PS

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The amazing Winchester

—big-machine memory for personal computers

Compact versions of "flying-head" disc drives bring new power to desk-top computing

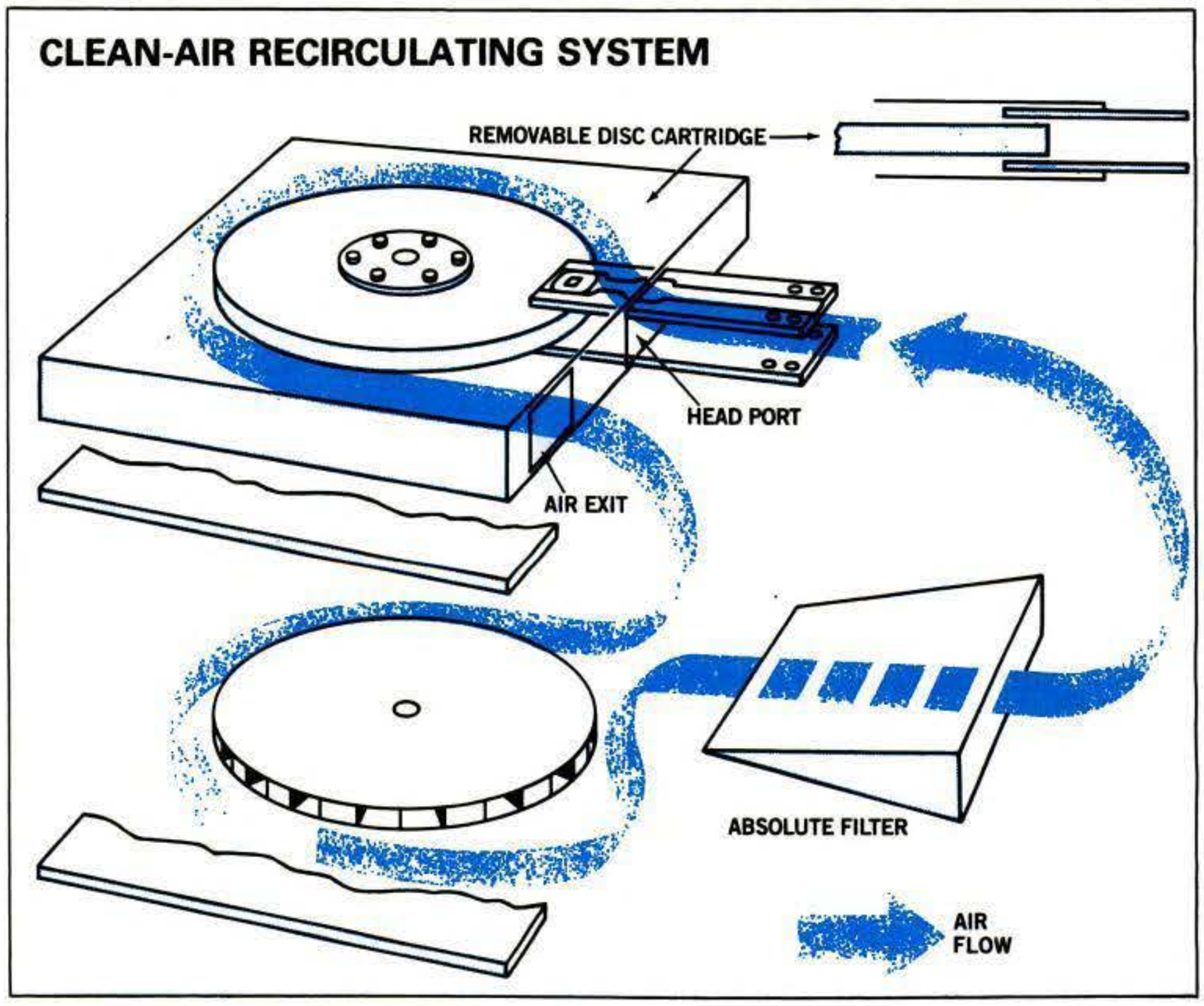
By JOHN FREE
ILLUSTRATIONS BY RON BERTUZZI

SCOTTS VALLEY, CALIF.

A photograph in Seagate Technology's conference room shows a vintage 1955 IBM disc machine. Its job: to store computer data for fast access. Room-filling cabinets dwarf the machine operator at a console. "There were 50 magnetic-storage discs, each 24 inches in diameter, plus a hydraulic actuating system—very slow by today's standards," said Doug Mahon, Seagate Technology's engineering vice-president.

"That drive had exactly the same capacity as this one—five megabytes [million bytes]," Mahon said. He lifted a metal container the size of a shoe box. Seagate has dubbed this remarkable feat of shrinkage the micro-Winchester. The drive package contains two or more 5¼-inch rigid metal discs that spin at high speed. Computer firms are snatching up Seagate's Winchesters—plus similar models from dozens of other firms—as fast as they're assembled.

The new hard-disc drives, unveiled first by Seagate in 1980, emerged at just the right time. "The 5¼-inch Winchester is the ideal mass-storage device to support the booming mar-



Pop-in cartridge devised by DMA Systems and other firms brings portability to 5¼-in. micro-Winchester hard discs. Pins in the drive open ports on five-megabyte cartridge for both air flow and heads, which "fly" above surfaces (see detail).

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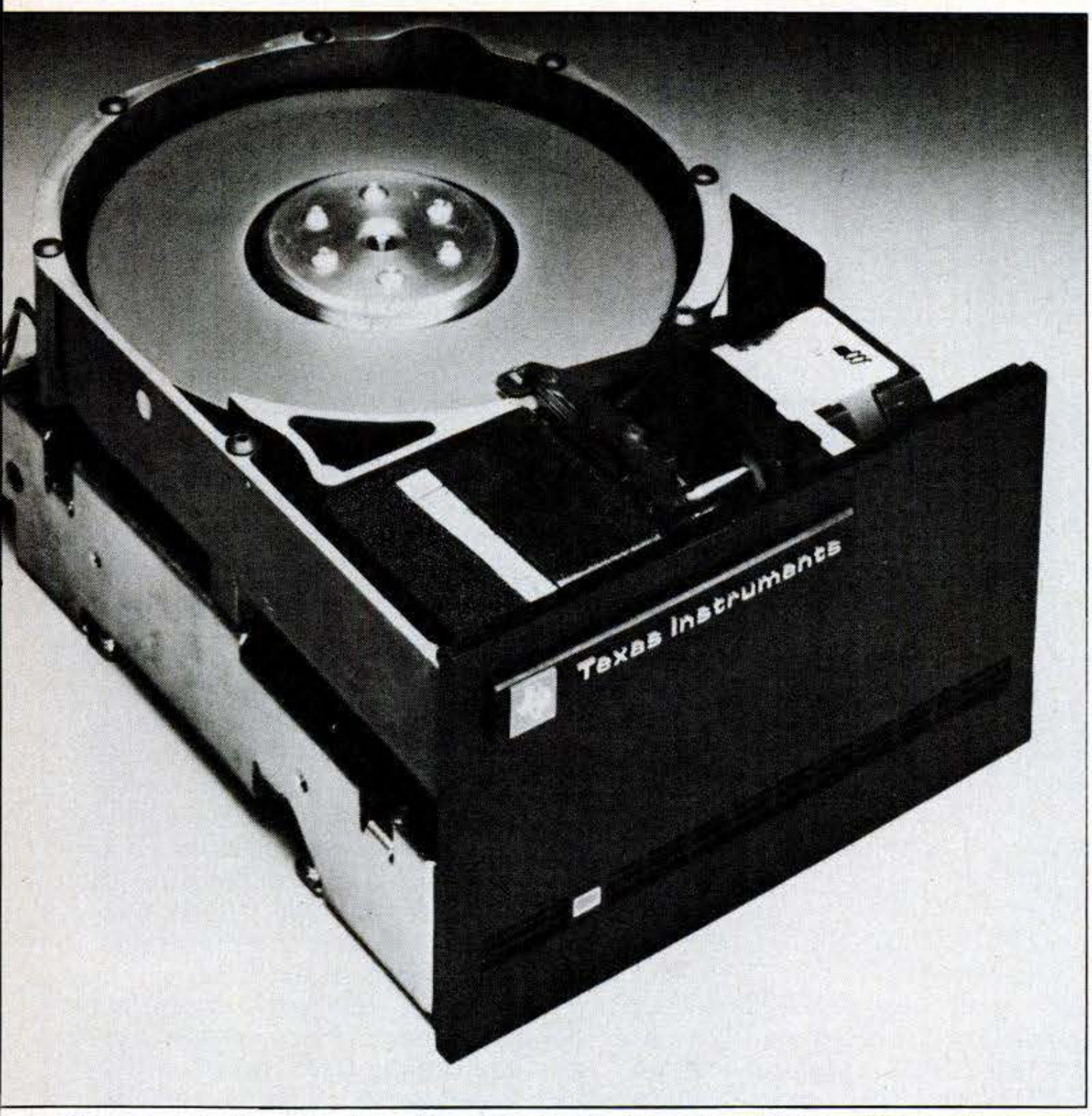

Disc stack in TI and other micro-Winchester drives is sealed against contaminants.

kets predicted for desk-top word-processing units, graphics-display systems [PS, June], and small business computers," says Tom Ellis, marketing manager, data-systems group, at Texas Instruments' Winchester plant in Houston, Tex. (TI is one firm licensed by Seagate.)

High-density semiconductor chips have put the computing power of older main-frame machines into these desk-top personal computers, but mass-memory hard discs lagged behind in cost effectiveness; you had to spend far more for a disc system than the microcomputer itself. Micro-Winchesters have changed that. Big-machine storage for small computers is now practical.

The need for the Winchester disc grew out of the limitations of the floppy disc that preceded it—and that is still the industry standard for most small computers. The floppy is made of a thin Mylar sheet coated with a magnetic substance such as iron oxide. A computer head writes or records information on it in exactly the same way a tape-recorder head records information on magnetic tape. Many tracks (analogous to the grooves on a phonograph record) can be used to record such information.

The system works well but has limitations. The read-write head touches the disc as it goes around, causing wear. It also limits the disc's speed to about 300 rpm, and that limits the speed with which information can be read in and out. Mylar expands and contracts with temperature, so tracks on the disc can't be packed too close. If the tracks are too close, expansion and contraction might cause the head to read the wrong one. In practice, current discs use about 96 tracks per inch. Consequently, most eight-inch floppies can store only about 500,000 characters—say, the equivalent of some 250 typed pages. (The maximum is about one million characters.) That's fine for most personal uses. But even a small company soon begins to overflow with payroll files, accounts receivable, and inventory lists.

Enter the Winchester. The basic technology, like so much else in the computer business, was pioneered by IBM in the early 1970's. The early version contained two 14-inch rigid discs, each one of which could store 30 megabytes of information. It was referred to as the 30-30 and came to be known as the Winchester, in honor of that company's famous rifle.

The advantages of the Winchester are formidable. Instead of plastic, it is made of polished aluminum with a thin coating of oxide. Aluminum does not change with temperature nearly as much as Mylar. Thus, tracks can be jammed much more closely together—up to about 250 per inch. Furthermore, the head does not ride directly on the oxide coating. Instead, it "flies" about 20 millionths of an inch above the coating on a cushion of air created by the disc's rotation. Thus the disc can spin at 3,600 rpm—more than 10 times faster than the floppy.

The payoff is that many current Winchesters can hold 5M [megabytes]—some 2,500 typewritten pages, or 10 times as much as a floppy—with that number rising rapidly. Moreover, they can handle information at far greater speeds. And because the enclosure is sealed, reliability is far greater.

It sounds simple, but in practice, the technological accomplishment is awesome. Think of a delicate recording head flying scant millionths of an inch above a speeding oxide surface. "If you scaled everything at mass and velocity," says Doug Mahon, "that head represents a 747 flying at Mach 4 an inch off the ground." Minute particles in the head path can tear material loose. Result? A chain reaction of particles and a head "crash."

In Houston at TI's Winchester quality-control room, I donned a lint-free gown, cap, boots, face mask, and gloves to see how crashes are prevented. Tucked into each drive is a filtration system that recirculates air in the drive and traps particles. Inside the drive it's a class-100 environment: no more than 100 particles a half micron (millionth of a meter) in size per cubic foot. Air in a typical office has about 300,000 such particles per cubic foot.

The emphasis at TI and Seagate, I found, is on reliability as well as super-clean conditions. At Seagate's rapidly expanding factory site, Tom Mitchell, operations vice-president, ushered me into a test room. I was hit by an ovenlike blast of heat. Before me, filling the entire room, some 3,000 micro-Winchesters were being "exercised." The whirring of their tiny motors sounded like a colony of giant bees. "By running them for four days we get all the infant mortality out," Mitchell said. The seven percent that are rejected stay at Seagate.

When the Winchester first came along, most companies tended to build the eight-inch version. But there was trouble. "Everybody had his own interface and controller," says Harvey Labban, marketing manager for TI's

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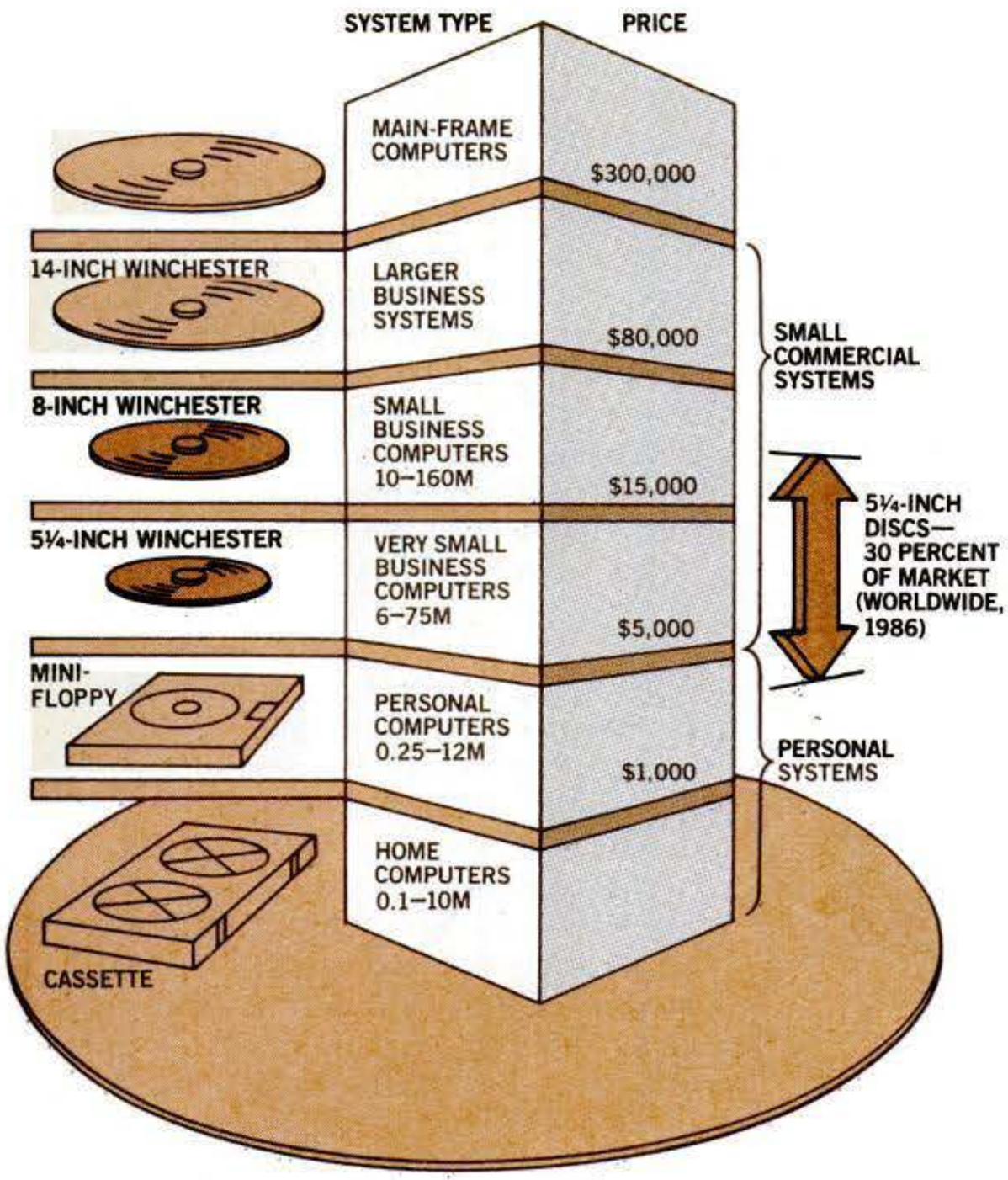

Micro-Winchesters, newest members of hard-disc family, are compact enough (5¼ in. dia.) to occupy cabinet space in personal computers designed for flexible 5¼-in. mini-floppies. Higher storage capacity of hard micro-discs should give them a wider slice of mass-memory-storage market in coming years. Not shown is coming generation of still-smaller hard discs (about 3½ in.) that will also achieve very high storage capacities through use of advanced technologies.

drive line. (Electronic controllers shuffle the data back and forth between the computer and disc drive.) Labban continues, "Customers were getting locked into one supplier."

Seagate, the firm that launched the micro-Winchester boom, decided to do something about that. Seagate founders Finis Conner, executive vice-president, and Alan Shugart, president and chairman, set two key goals when the company was established in 1979:

"The plan was to design a disc memory device that had exactly the same physical dimensions as the 5¼ mini-floppy-disc drive," Shugart told me. "Every desk-top computer in the world that was being shipped with more than one mini-floppy was a candidate for our drive," he said. "In general, we were offering 15 times the capacity at only three times the price."

Second, Seagate wanted to avoid a hodgepodge of technical standards, so the company decided, in the words of Alan Shugart, to "try and get as many potential competitors as possible to standardize the electrical interface. The 5¼ [inch] Winchester standard is a reaction to the chaos that was in the eight-inch hard-disc market."

Seagate engineers settled on a hard disc that spins at 3,600 rpm and reads data into computers at five megabits a second. Competitors using Seagate's standard have lots of leeway in design—but their drives must deliver data to controllers at this rate.

Now, with these standards and the 5¼-inch disc fast becoming the industry norm, a race for high-capacity micro-drives is on. The name of the game is how many magnetic bits—the on-and-off, north-and-south encoding of computer language—can be jammed into a square inch of disc coating. "Our first product ran at 250 tracks and 67,000 bits per inch," said Seagate's Mahon. But, he explained, that's seven times less than what IBM is packing into its big 14-inch drives (at 10 million bits per square inch).

There are several ways to design more capacity into a drive. To double its 6M drive to 12M, TI simply used a wider band of disc surface. But there's a limit to this, since densely packed magnetic bits begin interfering with each other on shorter (smaller circumference) inner tracks. Stepper motors used to jump read-write heads to the correct data tracks are too coarse when tracks and the gaps between them are very narrow. "That's what forces you from stepper motors to a servo," explained Norman Chandler, TI's disc-engineering manager. Magnetic data permanently recorded on discs—or other "signposts" built into them—can feed signals back to the controller. That tells it where the head is in relation to the desired track. This servo or feedback mechanism permits higher track densities.

Chandler outlined other technologies in the evolving Winchester market. Linear—and, one day, piezoelectric—motors can move heads faster, for example. Thin-film heads made with semiconductor techniques and perhaps integrated with signal preamplifiers have very narrow gaps to read or write smaller areas. And "flying" these heads ever closer to the surface uses the magnetic field before it widens; hence, finer resolution.

Also, thinner disc coatings permit denser packing of bits. Some firms are switching to ultra-thin metallic plating instead of iron oxide coats. Today's method of encoding signals for recording—modified frequency modulation—effectively doubles density over the older frequency-modulation method. And group-code recording, which puts more than one bit into a magnetic cell on the disc, can boost the density by 30 percent or more.

Some firms in the U.S. and many organizations in Japan are studying vertical, or perpendicular, recording technologies. Creating magnetic regions vertically on recording media, instead of stringing them out horizontally, is expected to boost densities 10 times or more. A compact 100M Winchester could become a 1G (gigabyte, or billion character) machine.

Advances, I discovered at the big computer show in Houston this summer, are coming fast. Makers of 5¼-inch Winchesters, adopting technology from older eight- and 14-inch hard-disc systems, are readying 50M and even 100M drives. Atasi has placed a 30M machine on the market; Seagate has shown a 38M machine scheduled to be shipped in 1983. Various companies are also making hard discs removable using new Winchester cartridges (see drawing on first page). Until now, 5¼-inch hard discs could operate only in factory-sealed shoe-box-size cases.

Other changes are coming rapidly, too. At first, most Winchesters were add-on units. Now they're beginning to appear as built-in original equipment in many lines. And all this activity is rapidly expanding the business; some 55,000 Winchesters will be sold this year. According to industry prediction, that figure will soar to about one million in 1985.

And, of course, prices are coming down. Micro-Winchesters now go for around $3,500 on the retail market (compared with $1,000 for a floppy drive). That should drop as production soars and competition sharpens.

Just how far can Winchesters go? Doug Mahon sketched a straight-line graph on a sheet of paper. "Historically, drives seem to increase in density by an order of magnitude every 30 months or so," he said. Micro-Winchesters seem to be on course. PS

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Clever c

holds work of any sh

Here's a quick, easy way to hold work for sanding, gluing, sawing, and more

By V. ELAINE SMAY

Richard Meyer, a retired architect and active workshop enthusiast, placed a board in the planing stop at the end of his workbench one day and began planing it. "The stop was old and worn and the board kept slipping off the bench," he says. "I was exasperated and decided there should be a better way to do the job."

Now there is. In fact, there's a better way to do a whole slew of clamping and holding jobs. After five years spent designing, hand-building prototypes, and getting a patent, the inventor is now marketing the Meyer-Vise, a unique and versatile bench-top clamping system.

A Meyer-Vise kit contains four plastic cams and a special fence with holding pins. These parts are made of a fiberglass-impregnated ABS plastic specially formulated to have both strength and the necessary coefficient of friction. The kit also contains instructions and a template for drilling a grid of 3/8-inch holes, two inches on centers, in your workbench top or in a separate panel. Each cam pivots on an offset pintle, which is sized to snug into the 3/8-inch holes. The fence has three diagonal rows of arched cutouts; the holding pins slip through them and into the holes. The size of the grid is the only limitation to the size of your clamping area. To hold larger pieces, two or more Meyer-Vises can be used together.

The photos show how to set up the vise. You put the fence on the drilled grid and secure it with the two holding pins. Then you place your work piece against it. Next, you push the cam pintles into holes near the periphery of the work piece and turn the cams to tighten the work piece against the fence. Two cams tighten when you turn them to the left, the other two turn to the right to tighten. Thus the vise can secure the work against pressure from all directions while you sand, plane, saw, drill, or rout it. It can also clamp work for gluing, forming, and assembling even intricate forms.

The Meyer-Vise is $14.45 (ppd.) from the Meyer-Vise Co., 5363 Agana Dr., Santa Barbara, Calif. 93111. PS

Meyer-Vise holds work firmly enough to allow drilling, sawing, or routing outboard of the bench. It can grip work as irregular as this rocking-chair section (inset).

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AUTO PREVIEW

FORD for '83

—slippery shapes, more power, and even a chop-top Mustang

Dearborn gets competitive with a meaner muscle car, fuel injection, five speeds, and leaner, cleaner models

By JIM DUNNE
PHOTOS BY GREG SHARKO

Major changes, ranging from completely new body shapes to detail substitutions in power trains, abound in the eight Ford Motor Company lines for 1983. And there are more to come later in the year. Styling revisions for the Thunderbird and Cougar coupes are the most obvious, but LTD, Marquis, and Capri also have eye-catching new designs.

Here's what to look for:

- Aerodynamically efficient shapes for luxury cars.
- Five-speed transmissions for selected Mustang/Capri and Escort/Lynx models.
- Smaller, redesigned LTD and Marquis.
- Fuel injection for Escort GT and Lynx RS.
- A talking instrument panel.
- More power for Mustang/Capri's 302 V8.

In addition, Ford plans to introduce two new car lines, the compact Tempo and Topaz sedans, later in the 1983 model year. Together, Ford's 1983 efforts total more than those of any other auto company. "You can never give the marketers enough new products, but this year the engineers have come closer than in any year I can recall," says Philip Benton Jr., vice-president of sales.

Slippery T-Bird

Ford decided to junk the boxy look of the 1982 Thunderbird and Cougar and go with a smoother, less-air-resistant shape. The result is eye-pleasing and efficient. Ford claims a 0.35 aerodynamic drag coefficient for Thunderbird, lower than any domestic car in its class. Changes in the body surfaces include concealed drip moldings, a sloping hood, tapered fenders over wheel openings, a sharply angled windshield, flush taillights, and a rear-deck spoiler.

Wheelbase of Thunderbird/Cougar is now 104 inches, four less than the 1982 model, and the weight has been shaved about 150 pounds. The standard engine is a 3.8-liter (231 cubic inch) V6. It can be teamed with either a three-speed or four-speed automatic transmission. Sometime later in the 1983-model run a 2.3-liter (140 cubic inch), four-cylinder, fuel-injection engine will be offered. It will have a five-speed manual-overdrive transmission.

For '83, Mercury dropped the XR7 suffix from the restyled Cougar's nameplate. It's nearly a twin to the Thunderbird in appearance, with only grille, taillights, and backlite differences visible from the outside. The formal, nearly perpendicular angle of the backlite was a much-discussed styling deviation among those who previewed the two cars. Suspension and steering are carry-over designs, so the chassis is well proved.

Ford's voice-alert system will be introduced on Thunderbirds and Cougars later in the model year. It delivers three oral messages: "The door is ajar," "the key is in the ignition," and "the headlights are on."

More muscle

The addition of five-speed transmissions to Mustang/Capri models and the Escort/Lynx and EXP/LN7 lines rounds out Ford's transmission lineup for small cars. The new gearboxes bring improved performance to the Mustang/Capri and better fuel economy to Escort/Lynx. Biggest news in the small-car group is the Escort GT/Lynx RS, which uses a fuel-injection version of the standard 1.6-liter (98 cubic inch), four-cylinder engine. Ford claims this model, equipped with a special suspension, five-speed manual transmission, and front and rear spoilers, will make zero to 60 mph in "about 11 seconds."

The fuel-injection system is a multi-port type that does not have the smooth transition between power settings that the carburetor engine offers. Instead, a push on the accelerator pedal is followed by an abrupt change in engine power. Ford engineers tried to eliminate this by altering the accelerator linkage, but the problem persists.

Mustang has a new grille and taillights, a convertible GLX body, and a four-barrel carburetor for the 302-cubic-inch (4.9 liter) V8. The 3.8-liter V6 engine replaces the 3.3-liter (201 cubic inch) in-line six. Base engine is an improved version of Ford's 2.3-liter four. Mercury Capri changes are similar in mechanical details, though that car has no convertible version. Capri does have a slick "bubble-back" hatch window not shared with the Mustang.

The talk around Ford is that the 1983 V8 Mustang may be "the quickest car built in America" this year. Based on my short experience with a prototype Mustang in a seat-of-the-pants test, that assessment may be close to the truth. The new car seems capable of zero-to-60-mph times in the eight-second range, which would put it close to the Corvette and at least a second ahead of the GM F-cars.

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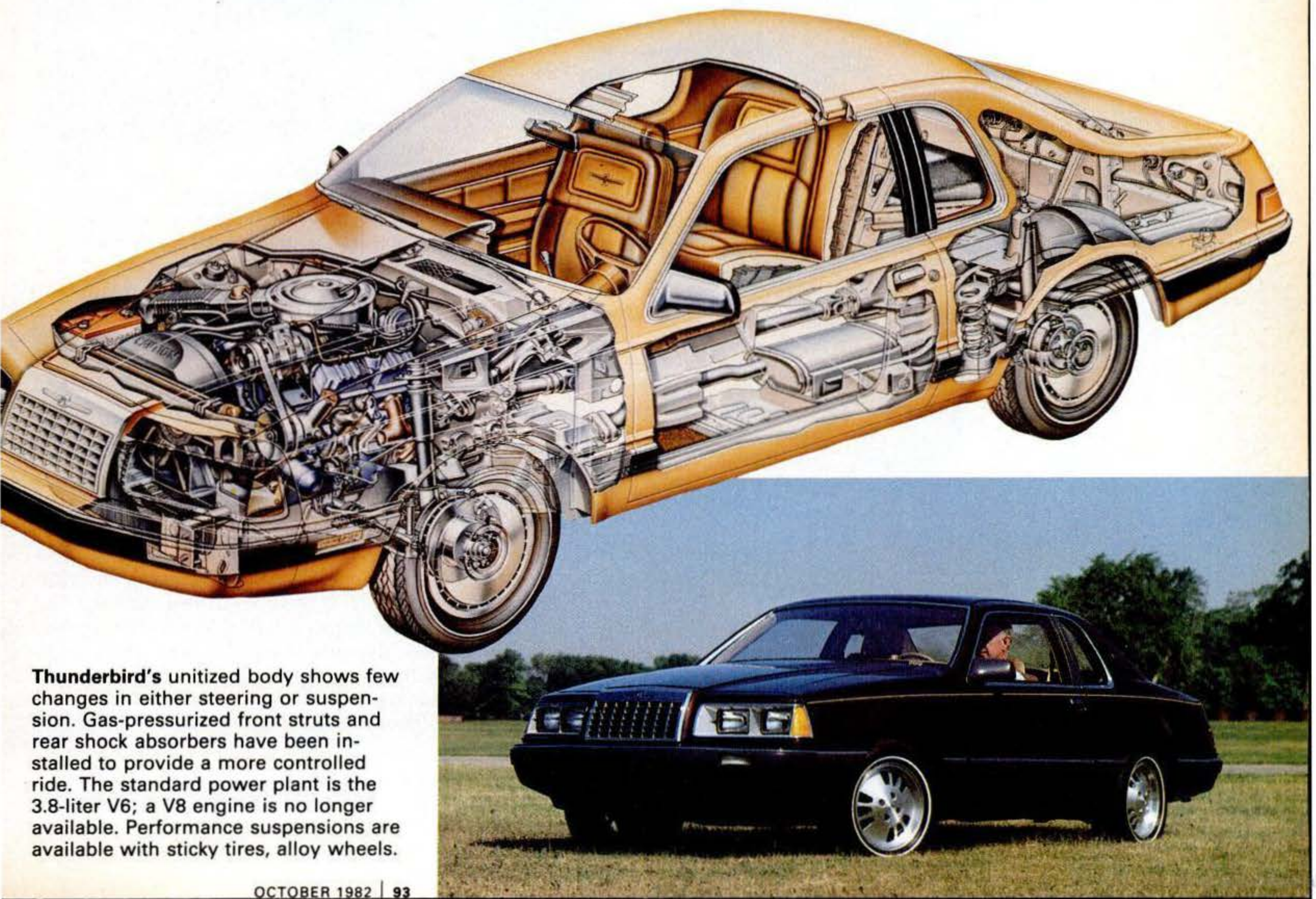
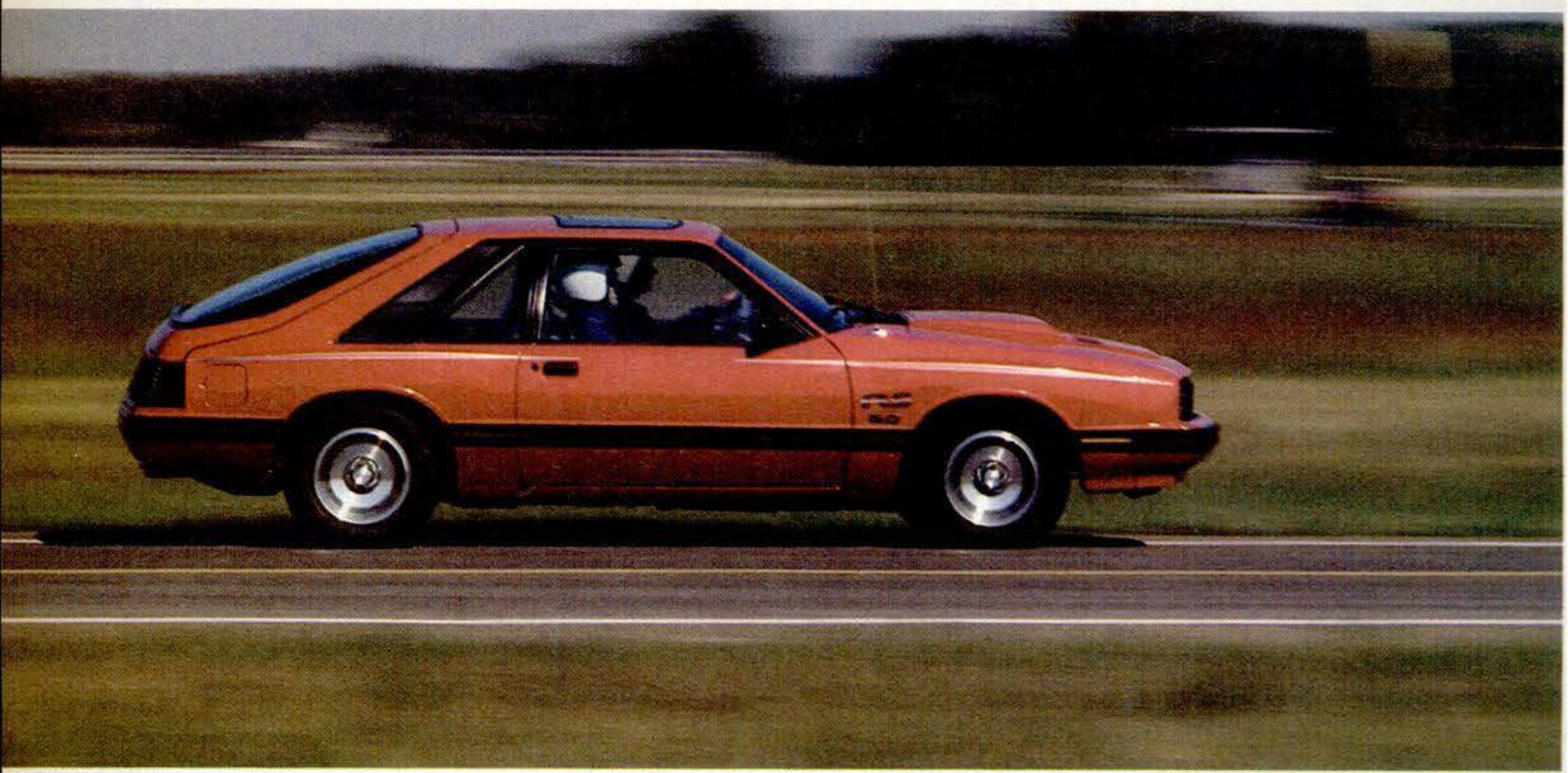
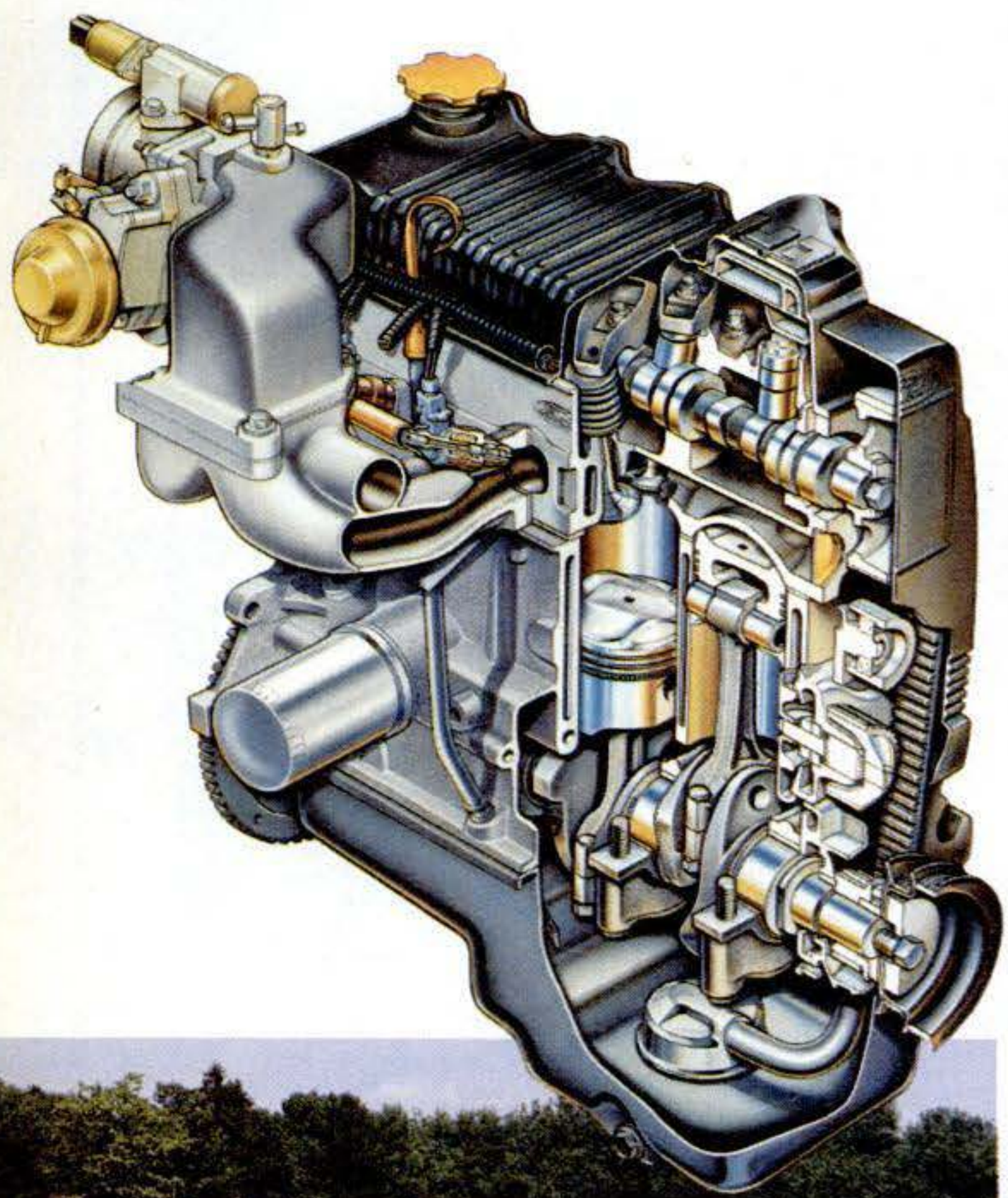
Mustang GLX convertible with 302-cu.-in. V8 engine seems custom-made for sun worshippers who like to travel in the fast lane.



Thunderbird's unitized body shows few changes in either steering or suspension. Gas-pressurized front struts and rear shock absorbers have been installed to provide a more controlled ride. The standard power plant is the 3.8-liter V6; a V8 engine is no longer available. Performance suspensions are available with sticky tires, alloy wheels.



Capri's slightly different front-end treatment and bubble-type rear hatch give it a profile distinct from that of the Mustang.



Little LTD uses a Fairmont chassis, improved to provide a quieter, smoother ride. There are three engine choices: 2.3-liter four (gasoline or propane), 3.3-liter in-line six, and 3.8-liter V6.

Two new plush series are offered in 1983. The additions, called LTD and Marquis, are small, fuel-efficient sedans and wagons that use a slightly altered Fairmont/Zephyr body. The carry-over bigger cars, LTD Crown Victoria and Grand Marquis, remain as four- and two-door models and station wagons.

Ford claims that extensive noise-control and ride-improvement details have been added to these models to bring them up to traditional big-car standards. Wind-tunnel testing has led to a reduction of wind noise as well as better aerodynamics, and chassis changes, such as gas-filled front struts and shock absorbers, improve the ride. Wheelbase for the little LTD is 105.5 inches versus 114.3 for the Crown Victoria; length is 196.5 versus 215 inches.

The new LTD and Marquis bump the Granada/Cougar sedans from Ford's 1983 line. Fairmont and Zephyr will be run as 1983 models partway through the year until the front-drive Tempo/Topaz makes its debut next spring. PS

Escort GT looks aggressive with its special exterior appointments and front and rear spoilers. And well it should: The optional fuel-injection 1.6-liter four (cross section, above left) is said to punch the sedan to 60 mph in 11 seconds.

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AUTO PREVIEW

GM for '83

—more punch for small cars, plus a sleek convertible

GM's J's get two peppier engines and a close-ratio five-speed transmission

By JIM DUNNE

You'll see few extravagant changes in the General Motors line for 1983, certainly none of the magnitude of those of the past half-dozen years. Instead, GM's five car divisions will dole out detail improvements: Four-cylinder engines, overdrive transmissions, and styling face lifts are the new-car buyer's appetite titillaters this year.

Two four-cylinder engines top the list of new features: a 1.8-liter overhead cam for the Pontiac J2000, Oldsmobile Firenza, and Buick Skyhawk, and a two-liter, fuel-injection version of the Chevy 1.8-liter for the Chevrolet Cavalier and Cadillac Cimarron as well as the other J-cars. The new engines are aimed at improving the poor performance of the GM J-cars. While the cars are not transformed into muscular types, off-the-line acceleration is about 10 percent better, according to prototype test results.

A new five-speed manual gearbox has been added to the J as another performance booster. The transmission has closer ratios between the first four gears and a more aggressive (economical) overdrive in fifth. It's imported from Isuzu, GM's associate in Japan. While the EPA ratings for the 1983 J-cars with the two-liter engine and five-speed may be lower than those of the 1982 models, the actual driving mileage may be better.

"We find that the prototype cars can loaf along at legal speeds on the highway," reports Cadillac's Thomas Patrick, manager of product planning for Cimarron. "So we expect that, overall, customers will get better mileage than they did last year."

Since the Cimarron has both the two-liter engine and five-speed, it's a good example for evaluating GM's most important 1983 revisions. Specification tables tell most of the story. The compression ratio was raised from 9.0:1 to 9.3:1. A throttle-body fuel-injection system replaces the carburetor of last year's 1.8-liter engine. The five-speed has a 0.74 overdrive ratio, compared with the 0.81 of the 1982 four-speed, plus more-economical ratios in the first three gears.

"We are looking at a two–2½-second improvement in acceleration to 60 mph," Patrick says. "And most of that's in the first few seconds, where the customer feels a big difference."

If Cadillac results are accurate, the Cimarron takes just over 14 seconds in the zero-to-60-mph test, just what the customer is looking for in a sporty luxury sedan.

A new combustion-chamber design holds one secret to the two-liter's increased smoothness and power. GM calls it "swirl port induction." That means the air-fuel mixture is brought into the combustion chamber in a swirling path through a curved intake-manifold end. The result is more efficient mixing plus faster burning of the mixture. The more homogeneous mixture is important. It permits the 9.3:1 compression ratio, the key to more engine sinew.

Cadillac also made changes in the chassis and body to upgrade the ride and cut down on noise inside the passenger compartment. "We have a new bushing mount for the engine instead of the opposed-pad design of 1982," points out Patrick. "It reduces idle shake by enhancing engine isolation."

To cut down on road noise, a softer rubber composition is used in Cimarron's rear-shock lower bushings. In the front-spring struts a gas-filled wrapper absorbs air from inside the reservoir, soaking up shock, in an exclusive Cadillac design that keeps strut damping constant "under all conditions."

I took a 60-mile comparison drive in both 1982 and 1983 Cimarrons and could easily detect the difference these changes make. The 1983 is obviously quieter in ride, the engine has less shake, and the performance—though not spectacular—is decidedly better, especially when the clutch is eased out. The 10 percent power boost means no speeding up of the engine to get the car rolling.

Pontiac is the lead division in producing the new 1.8-liter engine for the corporation. This is a world design that originated on the planning boards at GM's Adam Opel AG. The engine platform—pistons, crankshaft, iron block, aluminum head—is built in Brazil in what Ron Rogers, Pontiac's project manager for the engine, describes as "our most advanced and highest quality plant." Then it's shipped to Pontiac for attachment of all accessories, including a throttle-body fuel-injection system. Horsepower is about the same as that of the 1.8-liter four used in J-cars last year, but torque is better. Why replace last year's 1.8-liter four with another engine of the same size?

"It's more responsive off the line and at part throttle," explains Rogers. "And you get freedom from stalls, sags, and loss of power at high altitudes." All these add up to better drivability, according to Rogers.

In addition, the new engine is tuned

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Riviera convertible (top) is the first soft-top car for GM since the 1976 Eldorado. Price of the limited-production model: $24,000. Buick Regal T-Type coupe is equipped with a turbocharged engine, special wheels, trim, and paint (above).

for low-end torque at a sacrifice of high-speed power. "We want to get more off-the-line speed," Rogers continues. "Our J-car-customer feedback cited 'feeling of power' as the number-one preference."

Rogers claims that the new engine plus the change in gear ratios give J2000 just that. "The customer responds to the distance traveled [acceleration] in the first five seconds," Rogers says. "So zero-to-60-mph numbers can be misleading. With the 1983 engine he'll feel more power at start-up, and that's what he's looking for."

The balance of changes in GM's 1983 lineup are minor in comparison with the J-car's engine revisions, and they can be best described as freshening moves in selected car lines. New grilles show up on the G-coupes, and the X-cars have redesigned instrument panels. Buick's dreamy Riviera convertible could boost that car's popularity to double what it is now, except for the fact that production will

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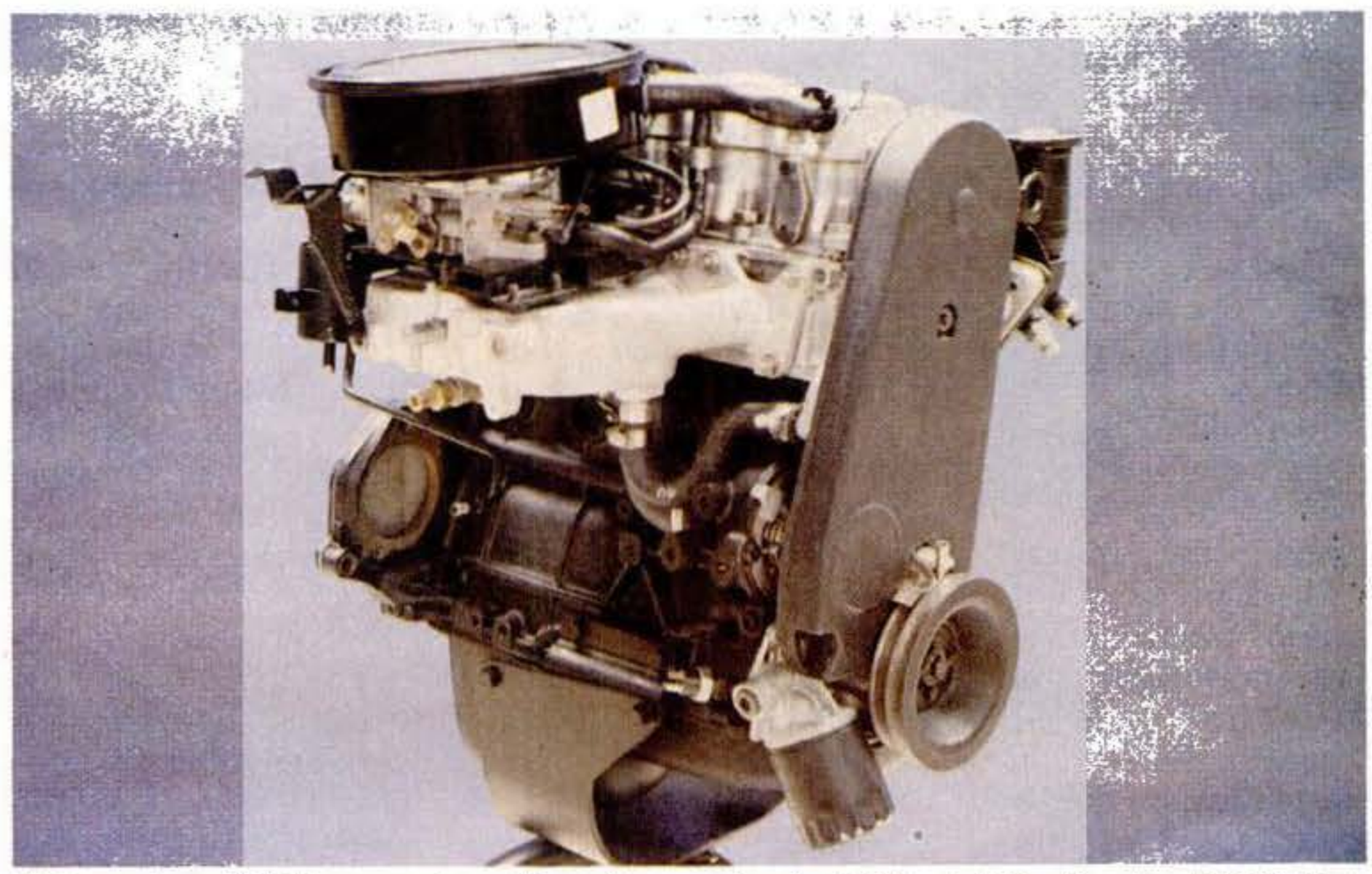
Cimarron (top) has a new grille and fog lamps; under the hood, a new engine and transmission. Monte Carlo (middle) has a new grille and a more luxurious interior. Firenza (bottom), Oldsmobile's version of the J-car, now comes as a wagon.

be limited to only a few thousand this year. The price of that car could be a big impediment, too: It's at the $24,000 level.

Transmission changes in other model lines are restricted but offer better fuel economy or more flexibility in manual-gearbox-equipped models. The A-cars—Celebrity, 6000, Century, and Ciera—have new overdrive automatics; Camaro and Firebird get a new five-speed manual; and all Chevettes and T1000's have five-speed manuals for 1983.

GM is saving the best for last in introducing its 1983 models. Early next year, the first major change in Corvette in 13 years will be shown. That car will be hundreds of pounds lighter and have a newly styled body. It will continue with its main-force 350-cu.-in. V8 engine to ensure that Corvette remains the premier performance car built by a U.S. manufacturer. We'll have a full report on it in an early '83 issue.



U.S. version of GM's newest world engine is the 1.8-liter overhead-cam four. Conceived in Germany and built in Brazil, engine is finished at Pontiac for J2000, Skyhawk, and Firenza. TBI and aluminum head are salient features for 1983.

AUTO PREVIEW

CHRYSLER for '83

—posh front-wheel-drive models for the comeback car company

The K-car line keeps growing, with two bigger and fancier models

By JIM DUNNE

Posh new sedans based on the K-car chassis and a Peugeot engine to replace the Volkswagen four now used in Horizon/Omni are at the heart of the changes in the 1983 Chrysler car lines. In addition, the comeback car maker offers improvements in engines, transmissions, and noise control that further enhance its entire front-wheel-drive lineup.

"Front-wheel drive coupled with excellent fuel economy, seating for up to six passengers, attractive styling, smooth ride, easy handling, and ease of service are features that buyers want," says Tom Pappert, vice-president of sales for Chrysler.

Those features are markedly evident in Chrysler Corp.'s two new prestige car lines,the Chrysler E Class and Dodge 600. The two cars are identical except for grille, taillight, and trim differences. They're the latest versions of Chrysler's now-famous K-cars, and they borrow heavily from the Reliant/Aries and LeBaron/400 models.

As befits a high-ticket car, E Class/600 received special attention to reduce noise and vibration. During sample rides in both E Class and the 600, I noted a big improvement in noise levels inside the car. There's also an improvement in interior space, with three more inches of stretch-out room in the rear. Here's what Chrysler engineers did:

Engine and transaxle noise and vibration: The engine mounts' rubber pads were softened by 30 percent to soak up engine and transaxle-gear noise. Air-induction hardware, including the air-cleaner body and snorkel, was stiffened with additional ribbing and insulated with rubber to isolate vibrations. Noise engineers must now pay special attention to the air system because as cars get lighter, small vibrations are transmitted through thinner body panels instead of being soaked up by the mass of heavy sheet metal. Separation of the passengers from engine-compartment noise was improved by adding another layer of sound-insulation material to the fire wall and by installing tighter, larger seals around the brake- and accelerator-pedal shafts. Further, counterweights and low-rate springs were installed in the transmission and clutch to dampen the effect of engine vibration.

Wind noise: Chrysler made 10 separate changes in the E Class/600 aimed at reducing wind noise. A plastic door-handle seal that prevents air leakage through the handle opening into the inner door cavity is one example. Sound-absorbent stuffing and mastic patching were added to other areas.

Door-closing noise: Finally, the old bugaboo of tinny-sounding doors was attacked. The handle and latching mechanism are completely insulated in areas where metal meets metal. Also, a coat of sound deadener was painted on the inside of the door's metal panel to stop the ringing noise when doors are slammed.

In a switch that was supposed to take place last year but was delayed for scheduling reasons, Chrysler chose the Peugeot overhead-valve 1.6-liter four-cylinder engine to replace the Volkswagen-based 1.7 liter as the standard power plant in the Horizon/Omni line. It has a cast-iron block and an aluminum cylinder head. Horsepower is posted at 62, one less than the 1.7.

The engine is currently available with either a four- or five-speed manual transmission. Later in '83, a three-speed automatic will be offered.

Chrysler's own 2.2-liter four has 12 percent more horsepower—up from 84 to 94—and nine percent more torque than it had when it was first introduced in 1981. In addition, fuel economy has been boosted and drivability improved.

Most of the improvements come from detailed tuning of the exhaust and induction systems and combustion chamber. A major contributor to the horsepower gain was an increase in compression ratio from 8.5:1 to 9.0:1. A new feedback ignition system that retards spark advance when engine knock is electronically detected was the key to safely increasing the compression.

Personally, I have a difficult time telling the difference between the 2.2-liter and the bigger 2.6-liter four that Chrysler offers as an option on its K-car lines. The refined 2.2 is a remarkable challenge to the 2.6.

Also new for '83 is a talking instrument panel Chrysler has dubbed "electronic voice alert." It is perhaps an improvement that Chrysler could have done without. (See my comments in "Detroit Report," this issue.)

The balance of Chrysler's 1983 lineup are virtually direct carry-overs from 1982. The New Yorker Fifth Avenue Edition, for example, is Chrysler's rear-drive prestige sedan, again available only in a four-door, six-passenger model. Later in the 1983 model year, a front-drive New Yorker will be introduced as the top model in the E Class line. And with that final model, Chrysler will complete its lineup of K-cars.

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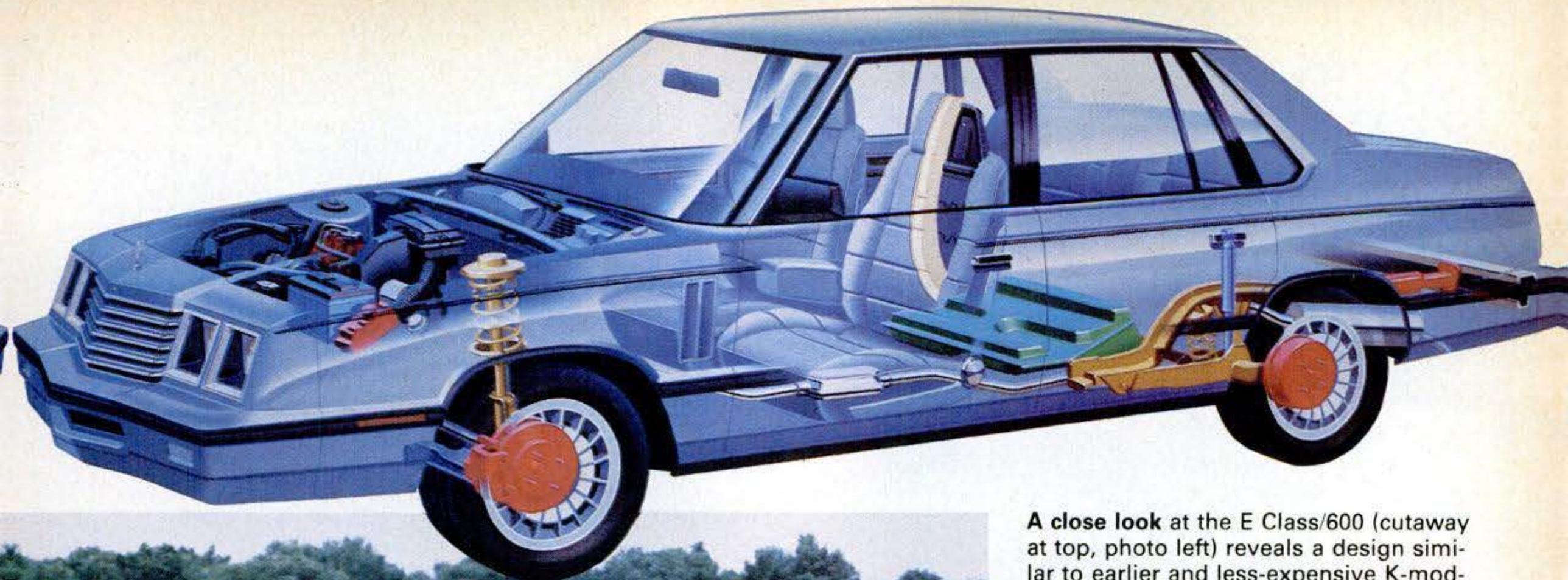


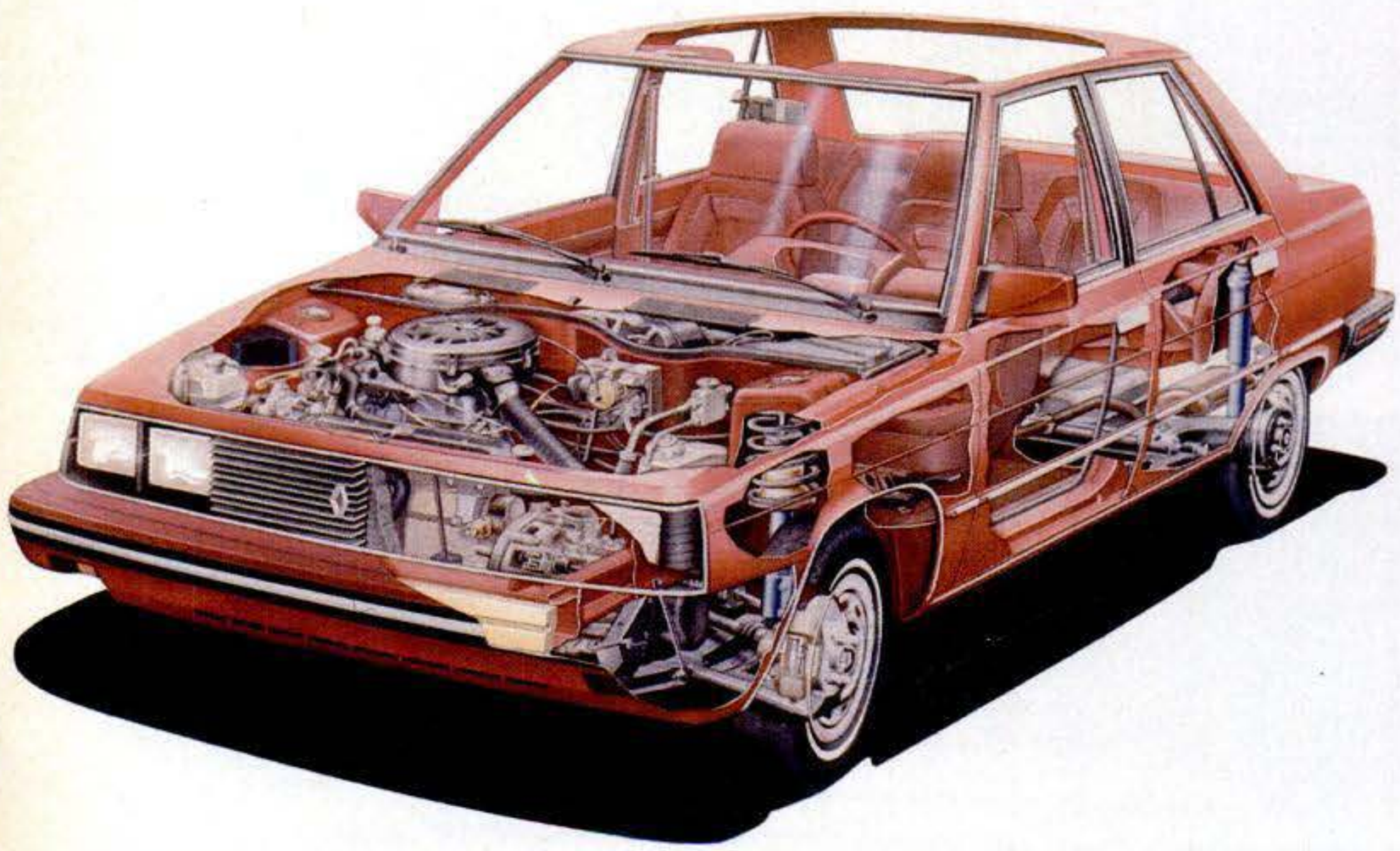
A close look at the E Class/600 (cutaway at top, photo left) reveals a design similar to earlier and less-expensive K-models. Bumper to bumper, the car measures 185.7 inches; that's almost 10 inches more than other K-cars. But drive trains are borrowed directly from the other K's. A much-improved 2.2-liter engine is standard, with the 2.6-liter four the only option. Fuel economy is expected to be in the 26-to-29-mpg range. Chrysler's parade of newly introduced domestic convertibles leads off with the handsome LeBaron soft top (below left). Below, Chrysler may have one of the cleanest-looking dash panels to come out of Detroit this year. Horizon/Omni (bottom) gets a new 1.6-liter engine from Peugeot to replace the 1.7-liter VW-based four; performance is on a par with the 1.7.

PHOTOS BY GREG SHARKO

AUTO PREVIEW

AMC for '83

Voila! Alliance—a state-of-the-art front drive



Alliance provides American Motors Corp. with a sorely needed state-of-the-art competitor for the subcompact-car market. The Americanized Renault 9 has an estimated EPA mileage rating of 35 mpg in the city and 50 on the highway. It's powered by a transversely mounted 1.4-liter, four-cylinder engine with fuel injection, and offers as standard a four-speed manual transmission, front-wheel drive, rack-and-pinion steering, and a unique rear twin-torsion-bar suspension. Inside, customers have their choice of vinyl, fabric, or leather, as well as other expected amenities such as air conditioning and special sound systems.

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Can a popular French car built in Kenosha, Wis., put AMC back in the running?

By JIM DUNNE

Renault is out to renew its former success with American buyers. Not since 1958, when the French marque led import sales, has Renault had a really winning year. With the introduction of the Renault Alliance, however, American Motors believes it can reawaken the interest of the American public in the Renault name.

Alliance is the Americanized version of the French-built Renault 9, a car that's been a blockbuster on the sales charts since its introduction to European buyers last fall. It's being built at AMC's refurbished Kenosha assembly plant, and AMC says it's just the product needed to put Renault back in the race as a top seller in the U.S. Here are the reasons:

- The Renault's features match or better those of other cars in its class.
- Fuel economy will be "the best of any U.S.-built gasoline car."
- The AMC dealer network will push Alliance as its value leader.
- Ride, comfort, and handling "are on a par with the best in its class."
- Manufacturing techniques will equal the best of Japanese makers'.

AMC will sell Alliance against the small sedans from Chrysler, GM, and Ford at the lower end and such imports as Accord and Stanza at the higher end. The front-drive car has most of the significant technical features found in cars of its class.

"Virtually all of the drive train and running gear is built in France," reports John K. Nemeth, director of RenAm Engineering. "The suspension systems are identical, so the ride is the same as in the R9. However, Alliance uses fuel injection; R9 has a carburetor. Also, some gear-ratio differences show up in the transmissions to give better fuel economy and to reduce emissions in Alliance."

Like most modern front-drive sedans, the engine is transversely mounted: This is the most space-efficient drive-line layout. The rear suspension is also designed with space efficiency as a prime consideration. It's a type not seen before in this country, with torsion bars set crosswise. Each bar is an assembly that extends no more than half the width of the rear-wheel track. However, the bars have the effective spring travel of twice their length. The secret is a doubling back of the bars within their own length. Each assembly is actually two metal tubes, one inside the other and joined at the inboard end by a spline arrangement. By twisting the wheel end, a spring action is set up through the length of both tubes, in effect doubling the length of the spring action. Benefits of this setup are independent suspension, longer spring travel, and a lower floor for the trunk and for rear-seat passengers.

Two body styles, five-passenger two- and four-door sedans, make up the line. (Later, you can expect three more styles: two hatchbacks and a station wagon.) There's a choice of transmissions: four- or five-speed manual or three-speed automatic.

Alliance weighs less than 2,000 pounds. That, plus the smallish size of the engine, is the underlying reason for its exceptional fuel economy. AMC predicted 35 mpg in city driving and 50 on the highway when the car was introduced to the press last June. Some diesel models from U.S. makers may surpass those figures, but AMC is confident that Alliance will be the leader among U.S.-built gasoline cars.

As part of its marketing plan, AMC is relying heavily on the fact that Alliance will combine American manufacturing skills and a solid dealer network with the best sedan in Renault's lineup. The 1,300-plus AMC dealers will feature the car as the premier value in the AMC-Renault line. That should guarantee 150,000 to 200,000 sales a year—AMC's goal.

Top priority is given to quality. AMC is copying the highly automated assembly techniques Renault uses in France. "Our record investment of $100 million in our Kenosha plant was made to ensure that the Renault Alliance quality level equals or exceeds the best of the competition," says George A. Maddox, vice-president of manufacturing operations. "Bodies are formed on an automated line that uses 28 Unimate robot welders. The engine cradle line is so precise that wheel alignment is set during assembly."

PS road test

My own 350-mile road test with Alliance confirmed AMC's claims of exceptional ride and handling. Greater spring travel for the rear wheels and a longer wheelbase than that normally found in a small car are two of the secrets here. The rear wheels have been moved back from the normal position in a car of this size. That makes a big difference in ride. Instead of the expected bouncy reaction, the ride was smooth and well controlled.

Added room is provided for the legs and feet of rear-seat passengers by the "pedestal base" of the front seats. Instead of having two runners on the left and right sides of the seat base, the seats are set on a single support below the center of the cushion. Rear-seat passengers can place a foot on either side of the pedestal beneath the seats where more room for stretching out is available. I found this setup an ideal solution for giving rear-seat passengers more foot room. Why didn't someone think of this sooner?

In addition, the front seats have three position adjustments, including a rocking motion that should allow even the most discriminating to find a comfortable position.

On the road, the car is carefully obedient to the turns of the steering wheel, with little of the under- and over-steer response typical of some front-drive sedans. The manual steering system is precise and predictable.

Like other Renaults, Alliance is designed to operate at relatively high engine speeds. But engine noise and vibration remain at low levels and do not become the problems they were on previous Renault products. The 49-state four-cylinder engine is enhanced by a Bendix throttle-body fuel-injection system that makes for smooth, even running; quick starts; and more control over fuel consumption. California models, because of stricter emission requirements, come with a more sophisticated Bosch multi-point system.

Performance is sprightly with the five-speed transmission. Using only the first three gears, zero-to-60-mph times average just over 15 seconds. That compares favorably with Chevette and is slightly behind similarly equipped Horizons and Escorts. Care must be taken to avoid front-wheel spin during full-throttle takeoffs. Revs must be kept well below 4,000.

Alliance's styling is essentially a carry-over from the R9. Headlights are dual American-style sealed beams. The only major differences show up in the bumpers, grille, and taillights. The bumpers are smoothly integrated into the front and rear fenders, and bumper color matches body paint. AMC says five-mph bumpers will remain on the car indefinitely, despite the recent 2½-mph allowance by federal standards.

Will Alliance do for AMC what the K-cars did for Chrysler? Only the buying public knows for sure. But Alliance represents an impressive effort. Engineers and designers from both AMC and Renault have worked closely for more than two years to present a technically advanced and aesthetically appealing automobile. You can expect a complete PS road test of Alliance in a future issue. PS

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What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS

Cold pad

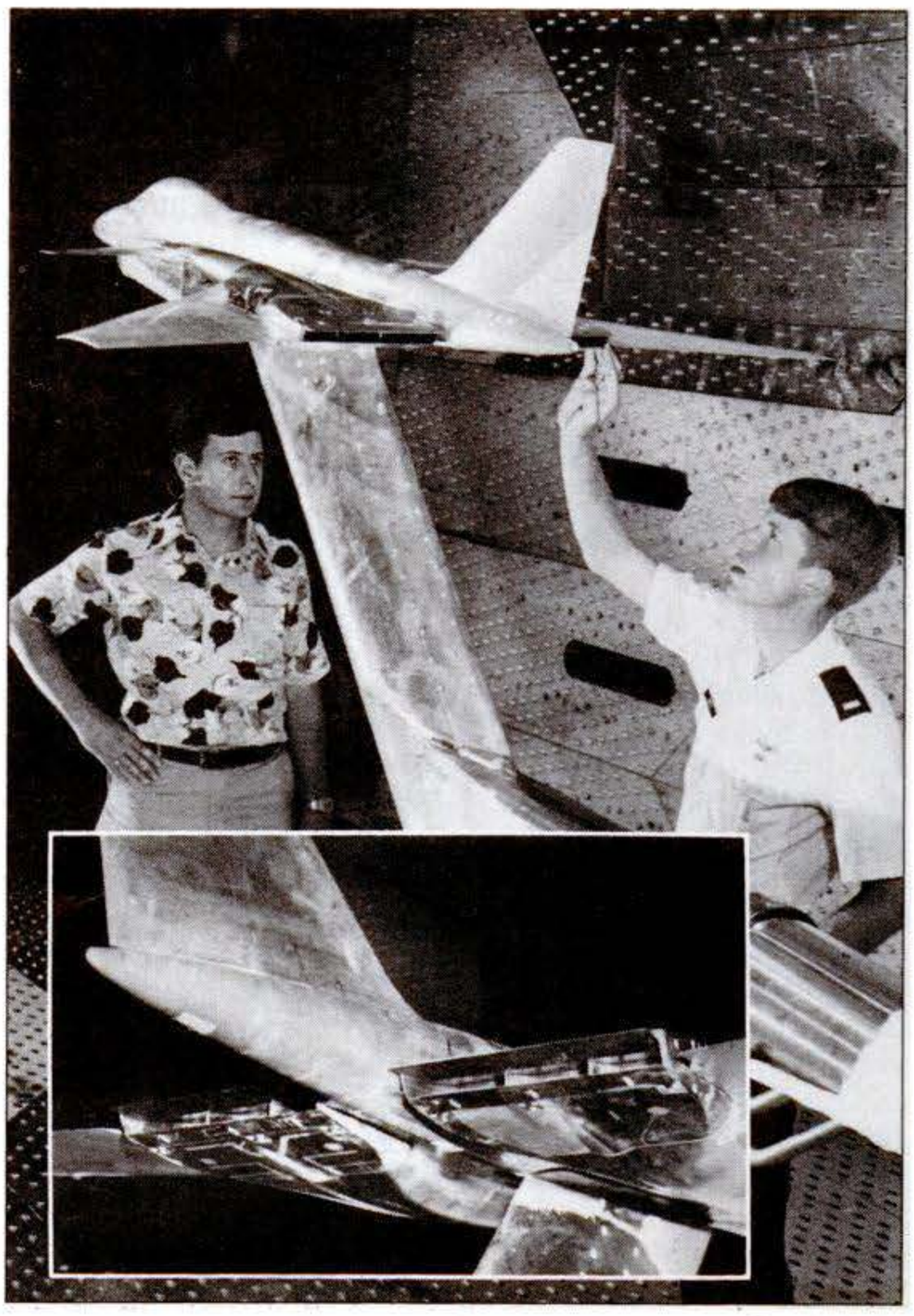
Tape or hold on a Sportslife pad to relieve muscular pain and swelling from contact sports or exercise, says the maker. Pressure produces a cooling effect that lasts about 30 minutes. Wedo, Im Portugall 9c, D-6370 Oberursel near Frankfurt, W. Germany.

Hovercraft fireboat

Two 40-ton fireboats ordered for patrol of a 38-mile waterfront in Tacoma, Wash., won't produce damaging wakes—even at 30 knots. The boats, which can deliver over half their own weight in water each minute, ride on an air cushion. Britain's Vosper Hovermarine Ltd. makes them.

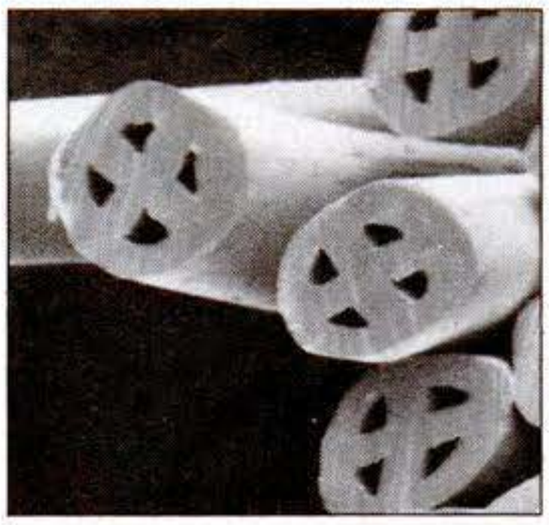
Advanced fighter

Movable rectangular engine nozzles that deflect exhaust may make future fighters more maneuverable. A wind-tunnel concept model undergoes tests at the Air Force's Arnold Development Center. Small canard wings up front help trim pitching movements from the nozzles.



Bike bottle

Just slip the water-bottle loop onto the hook-covered base and you're ready to roll, says Cannondale Corp. (9 Brookside Place, Georgetown, Conn. 06829-0122). The fast-connect, 24-ounce bottle for bikes has a wide mouth for ice. Price: $9.95.



Warm fibers

Tiny pockets of air trapped in Dacron 113 polyester provide its most thermally efficient insulation yet, says Du Pont. The four-hole fiber, shown in a photomicrograph cross section, was field-tested in sleeping bags by the American Everest expedition.

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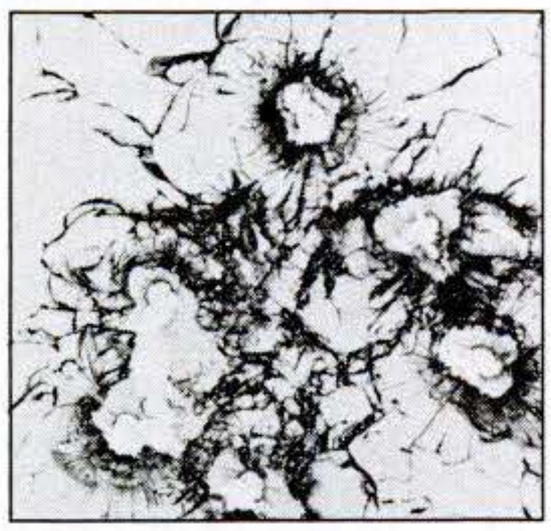
Peregrine trainer

Unusual winglets on the single-engine Peregrine jet point down instead of up. The aerodynamic feature adds lift and reduces vortex drag. The Gulfstream American (Bethany, Okla.) test-bed aircraft, proposed as a trainer, has had over 100 hours of flight tests.



Safety film

Clear Saxonite safety film applied to plate or window glass lessens the danger of flying glass shards, claims National Metallizing (Cranbury, N.J. 08512). The tough organic film has a self-adhesive, pressure-sensitive coating. It's applied by factory-trained workers.

Long-life batteries

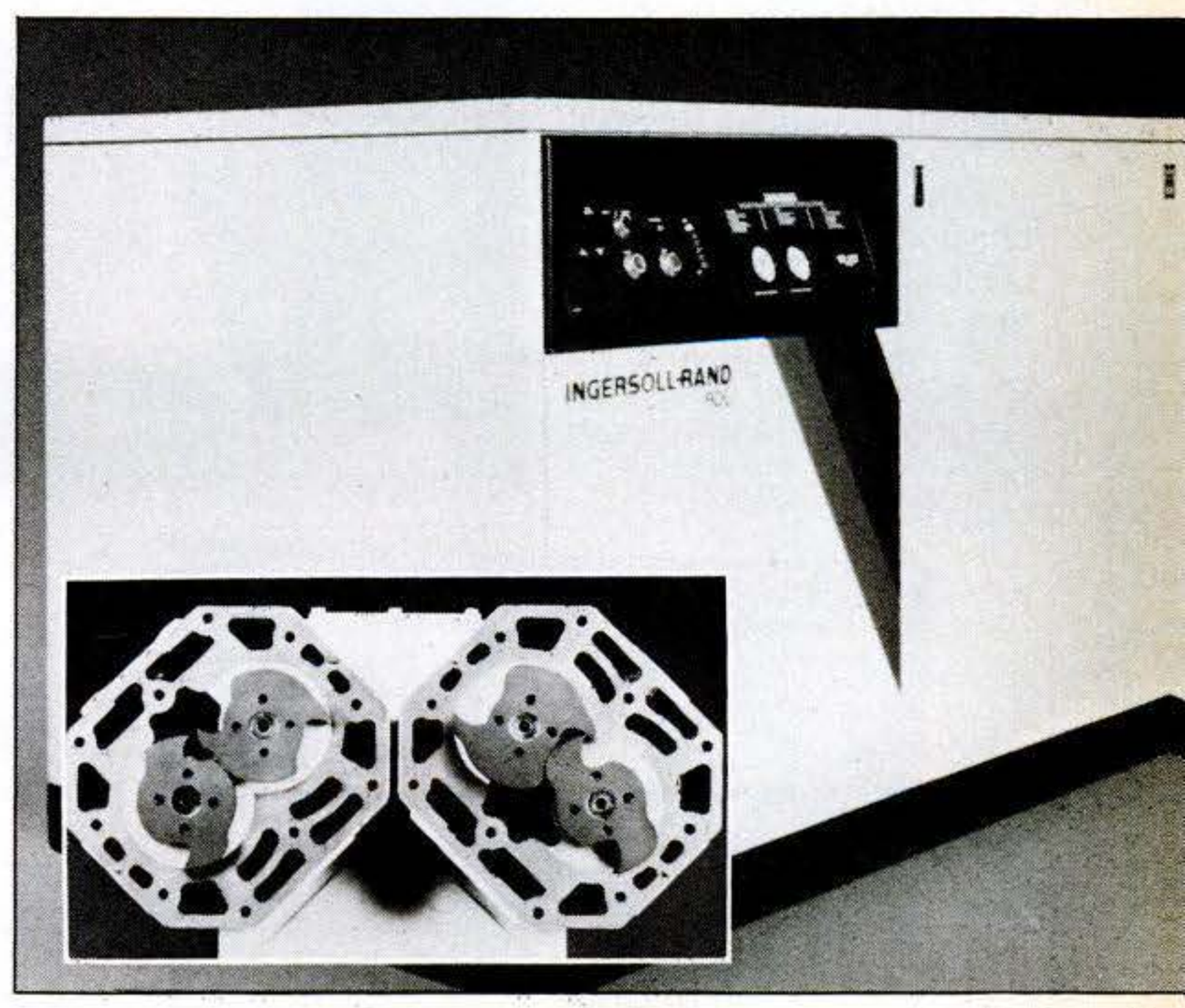
Duracell alkaline lantern batteries can hold most of their original capacity for up to three years, claims Duracell International (Bethel, Conn.). The MN908 has four cells and the MN918, eight cells. Both six-volt manganese batteries replace zinc-carbon designs.

Jogger's sprayer

Squeeze the pistol-like sprayer on Aquarius for a moistening spritz while you're on the go. The quart-sized backpack lets runners or other athletes prevent dehydration without stopping for a drink. Price: $30. Plasmetics, Inc., 46 Old Camplain Rd., Somerville, N.J. 08876.

Oil-less compressor

A rotary, two-stage compressor delivers oil-free air for industrial applications. That's because the compression chamber needs no oil or coolant, says Ingersoll-Rand (Woodcliff Lake, N.J.). Rotors (inset) in its RDL model trap and compress air twice per revolution without touching.



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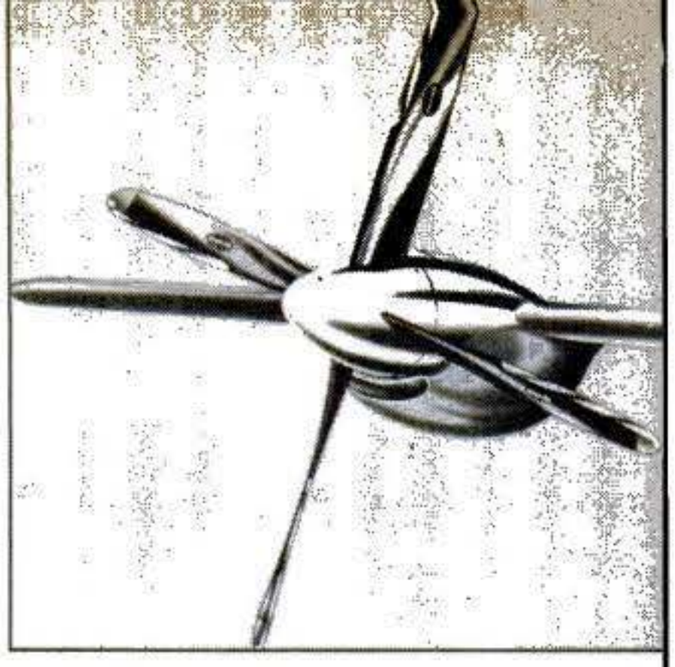
What's New



Le fast car

Le Car, Renault's baby, grows up. The two-door hatch is only two in. longer than the standard model. But, fitted with the R5 Gordini Turbo, the little car sprints to 62 mph in 9.1 seconds and can top 115 mph. Four large disc brakes give stopping power to match performance.

Plastic prop

The propeller isn't all plastic. Each blade encases an aluminum spar within its fiberglass shell. This weight-saving design by Hamilton Standard should improve performance of future advanced commuter turboprops such as the 49-passenger French-Italian ATR-4.

Rigid racket

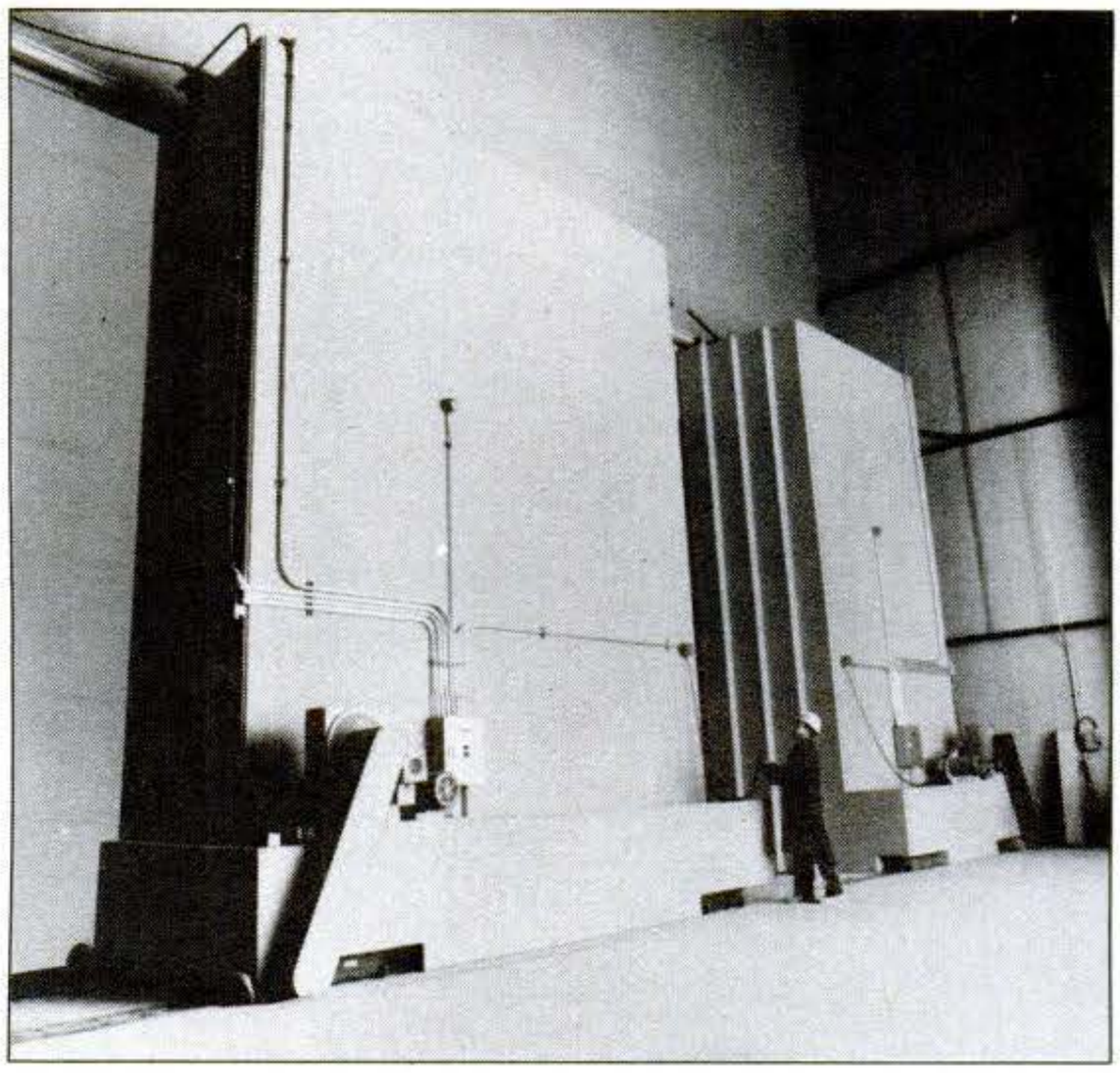
The Max 200G is hollow-injection-molded. This new technique makes the graphite racket stiffer—and easier to control—than other mid-size rackets, says Dunlop Sports (Box 3070, Greenville, S.C.). The racket also has a five percent larger "sweet spot" than others its size. $170.

Underwater tool

Sea water—not oil—powers this hydraulic wrench. With it, a Navy diver drilled a ⅜-in.-diameter hole in a ½-in.-thick steel plate. The tool also fastens bolts, providing more than 1,100 ft.-lbs. of torque in 10 seconds. Just one hose supplies the pressurized sea water.

Colossal door

At 360 tons this 23-ft.-high door could guard a treasure. The poured-concrete door has just ¼-in. clearance under its eight-ft.-thick base; it keeps radiation from escaping a high-energy-laser target room. Overly Mfg. Co. (Greensburg, Pa.) made it for Lawrence Livermore Lab.



Cost cutter

Cheaper electricity from the sun—that's the promise of this photovoltaic array. It's the first commercially available panel made with semi-crystalline silicon solar cells. These are easier to make than single-crystal versions—and should be cheaper, says Solarex (Rockville, Md.).

Light clothes

Foul-weather wear needn't weigh you down, says Sierra West (6 E. Yanonali St., Santa Barbara, Calif. 93101). Made of 1.1-oz. rip-stop nylon laminated to "breathable" Gore-Tex, the L.I.T.E. Gear jacket weighs 11 oz.; matching pants, seven oz. The $239 outfit will lighten your wallet, too.

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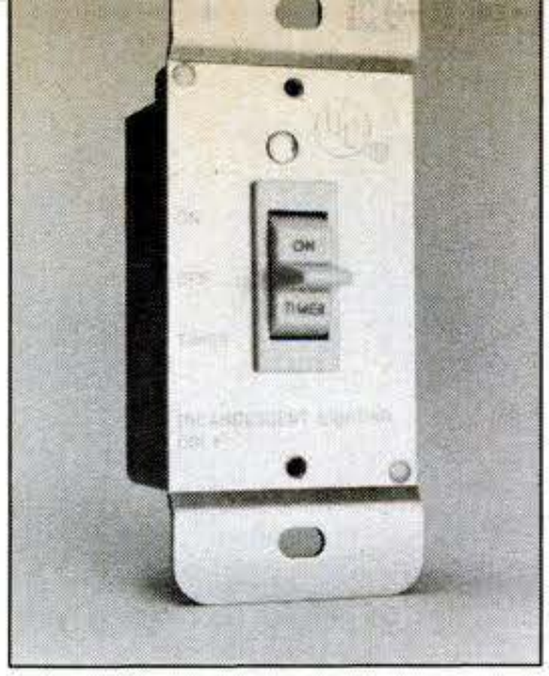
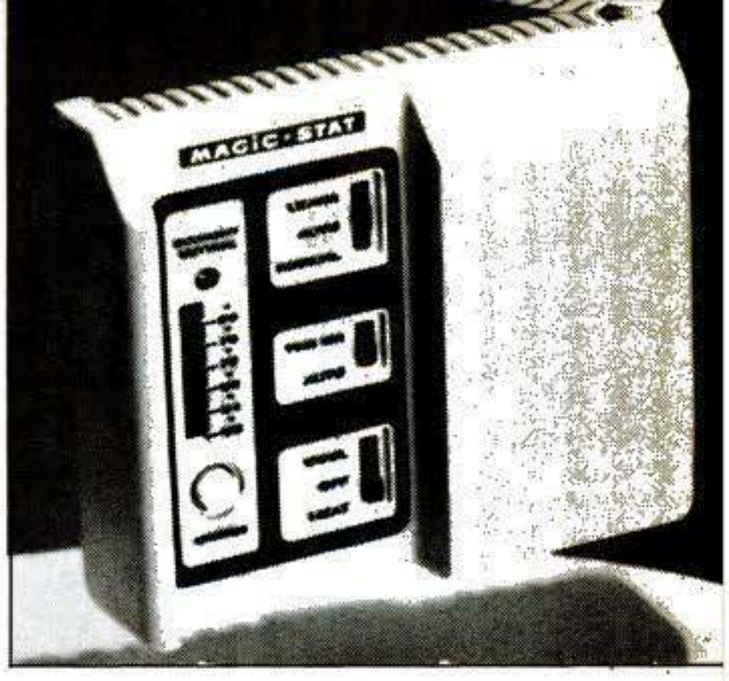
What's New IN HOME IMPROVEMENT

BY SUSAN RENNER-SMITH



Thinking 'stat

On extra-cold days, Magic-Stat starts the furnace early. A microprocessor lets you program six different temperatures for each day by pushing only the "change" button. Quad Six (3135 S. State St., Ann Arbor, Mich. 48104) makes it. Price: $80.

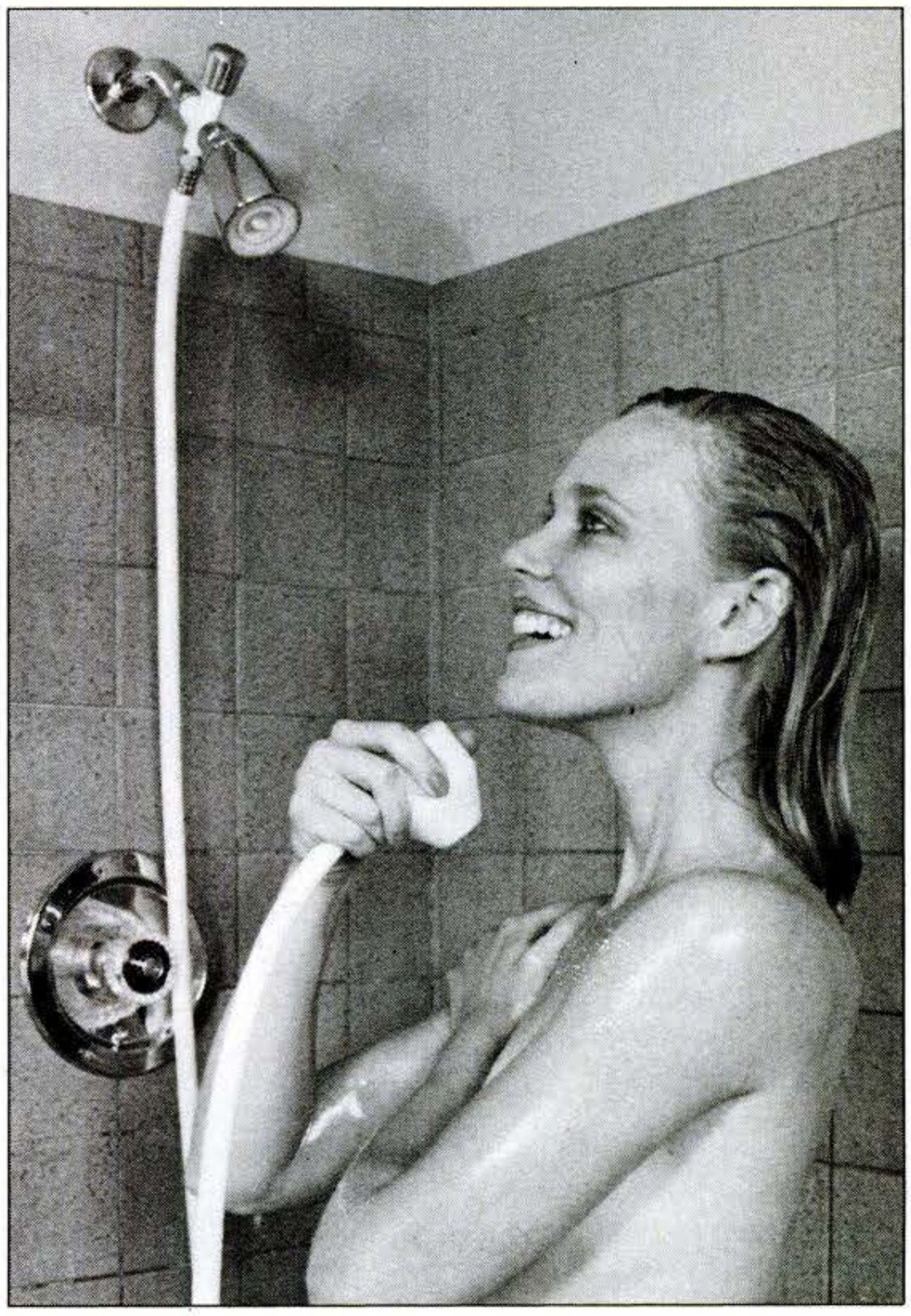


Auto switch

Do you—or your kids—always forget to turn off the basement light? The Lites-Off switch will do it for you. In the timer position, it cuts the light after 15 minutes. Ectec, 19138 Old Vineyard Rd., Los Gatos, Calif. 95030. $14.95.

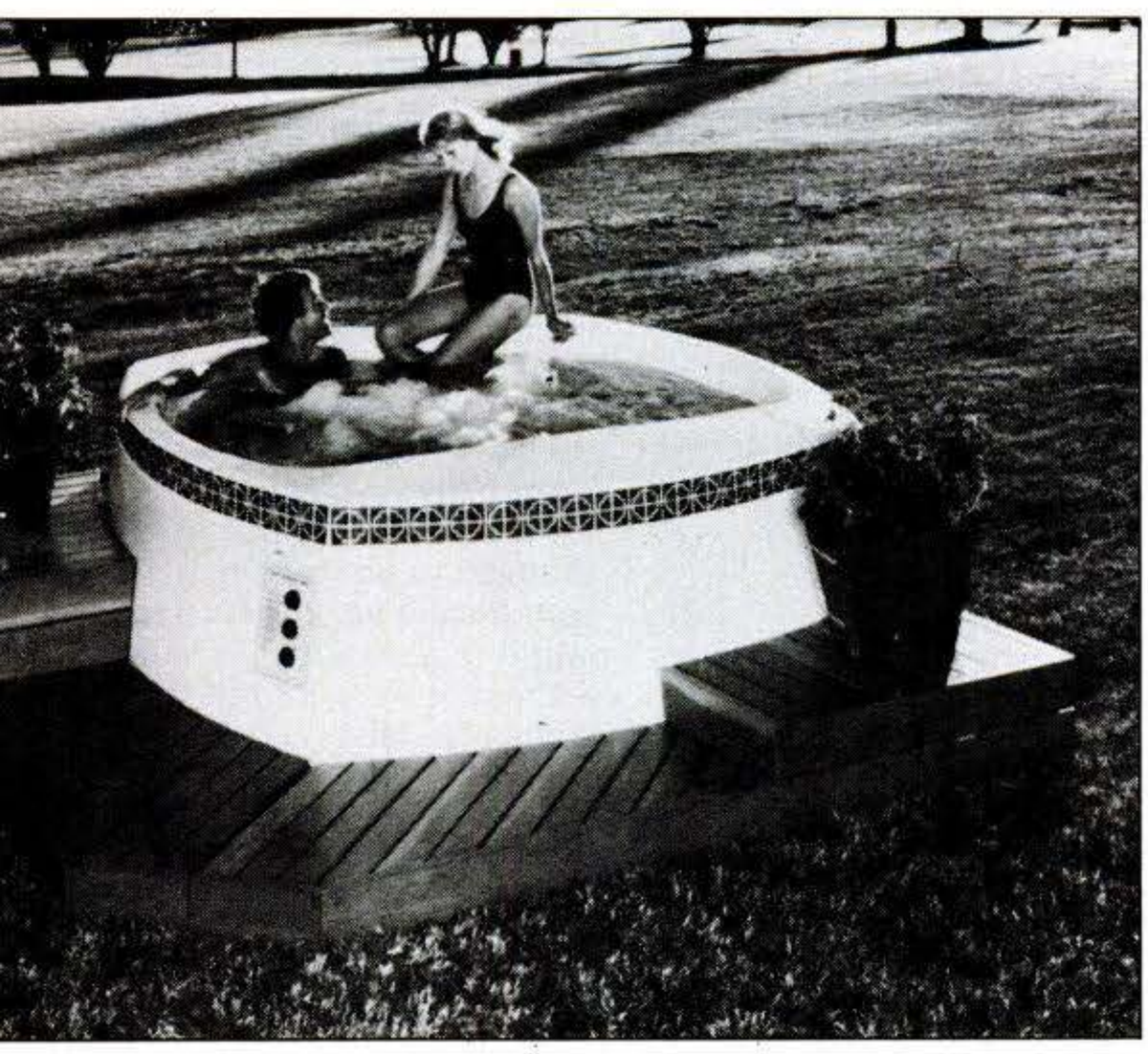
Aerosol caulks

Touch 'n Caulk's nozzle dispenses paintable acrylic caulk, says Convenience Prod., 4205 Forest Pk. Blvd., St. Louis, Mo. 63108. An 11-oz. can costs $5.29. Acrylic Caulking Stuff resists water and mildew, claims Insta-Foam (1500 Cedarwood Dr., Joliet, Ill. 60435). $5.29.



Most miserly shower?

Most water-saving shower heads spray about three gallons of water a minute. The UltraSperse 310 has a miserly flow of one gallon per minute, says Minnco (Box 310, Arnold, Md. 21012). And when you release the button to soap up, the flow dwindles to a dribble. The Navy developed this scanty shower to save water aboard its ships and is presently outfitting the entire surface fleet with it. You can install one in your home for $52.45.



Heat-holding spa

No more tepid whirlpools: Hot Spring Spa has 130 lbs. of foam insulation inside its plastic shell. A thick, vinyl-covered foam top also keeps the heat in, says Watkins Mfg. Corp. (342 E. Myrtle St., San Marcos, Calif. 92069). The spa costs $3,995.

Ceiling heater

For a clutter-free floor, put the heater on the ceiling. Warm 'n Safe radiant heater keeps an eight-ft.-sq. area below it comfortable, says Armstrong. The two-by-four-ft. panel mounts on plaster and dry wall or in the grid of a dropped ceiling. $90.

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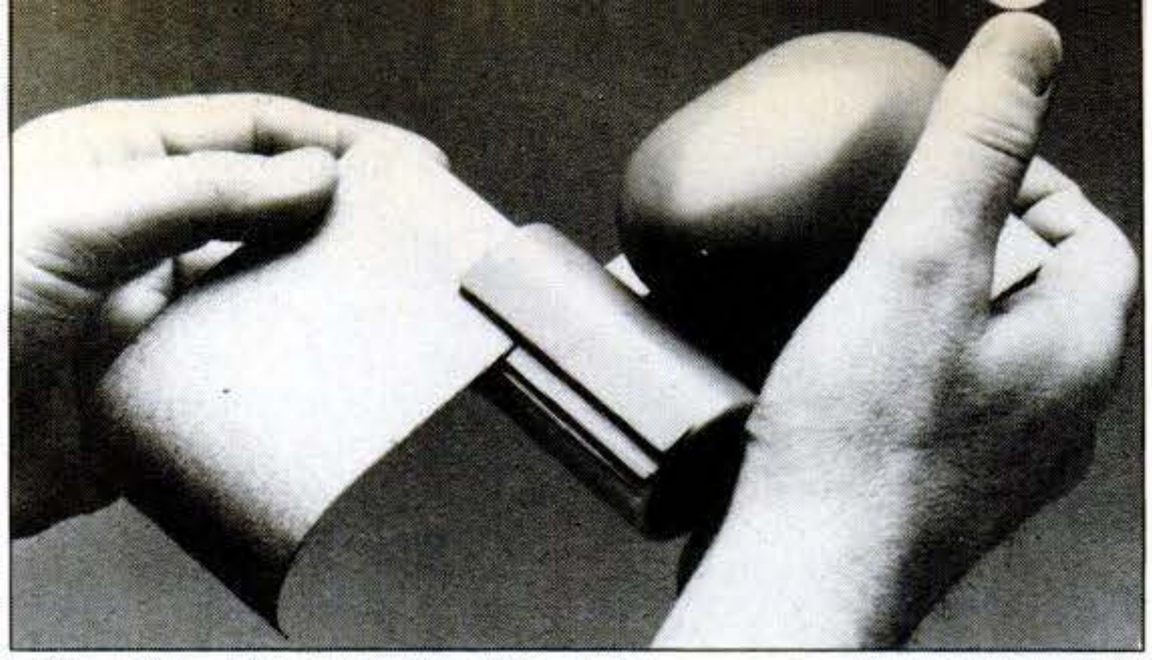
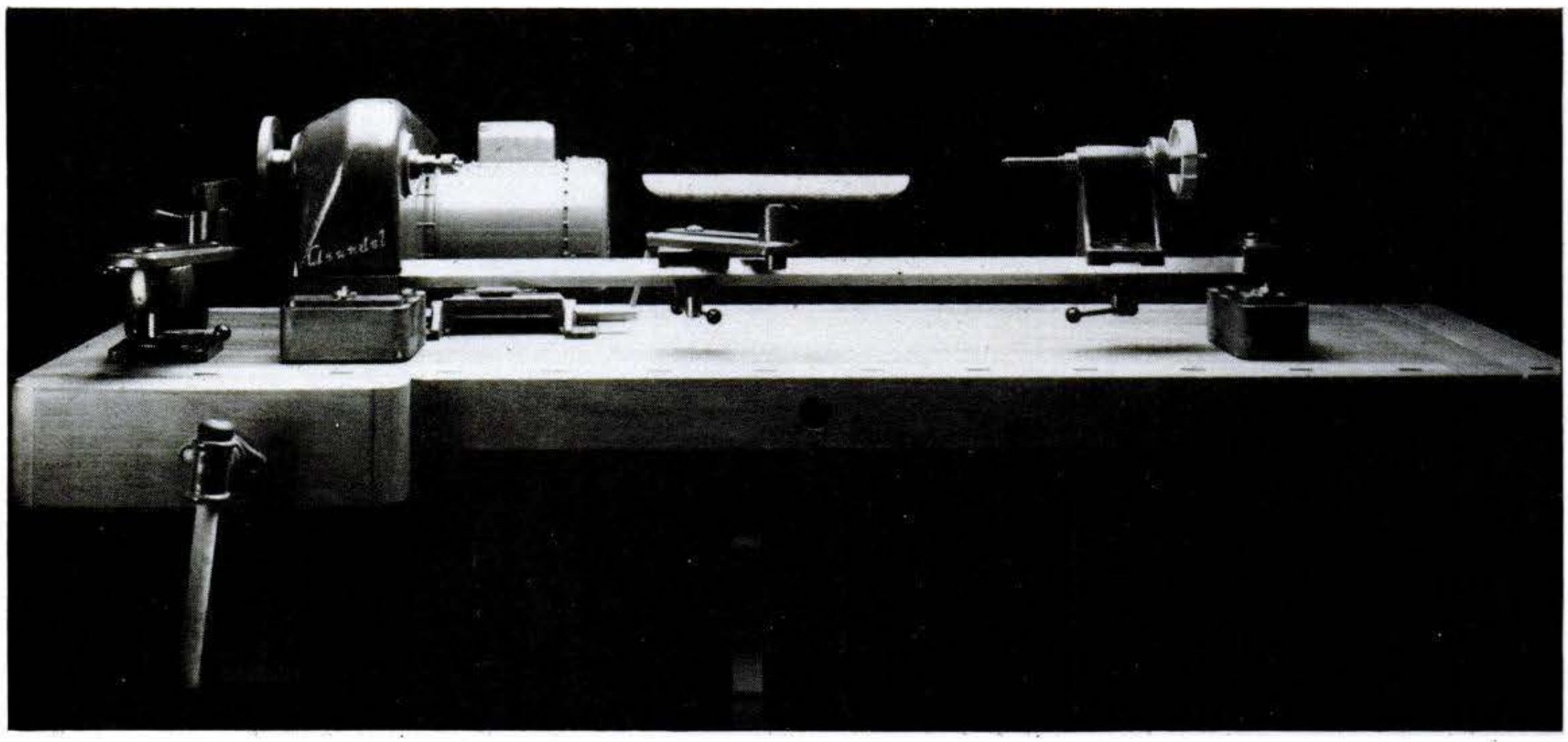
What's New IN TOOLS

BY V. ELAINE SMAY



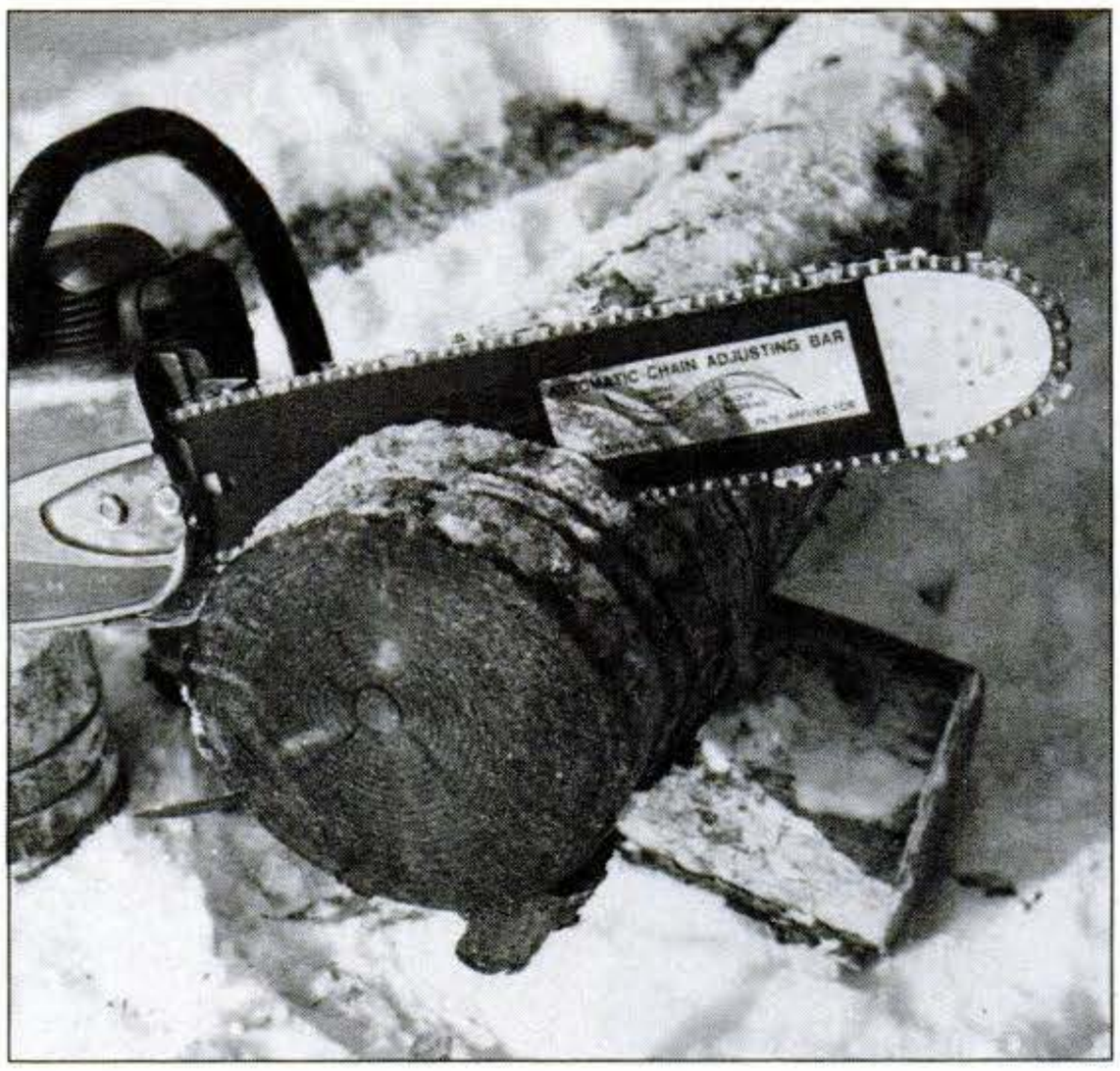
Handy sander

Adhesive-backed sandpaper in a roll slides into this molded-plastic sanding block from 3M. You slip in a roll and pull out enough to cover the 2½-by-five-in. pad. Need a change? Tear off the old section and pull out a new one. Sander is $6.50; refill rolls, $2.85.



English lathes

Two wood-turning lathes made by Arundel of England are now available from Garrett Wade Co., Inc. (161 Ave. of the Americas, New York, N.Y. 10013). The standard M230 ($795) takes up to nine-by-36-in. stock. Heavy-duty M300 ($1,495) handles stock up to 12 by 42 in.



Self-adjusting bar

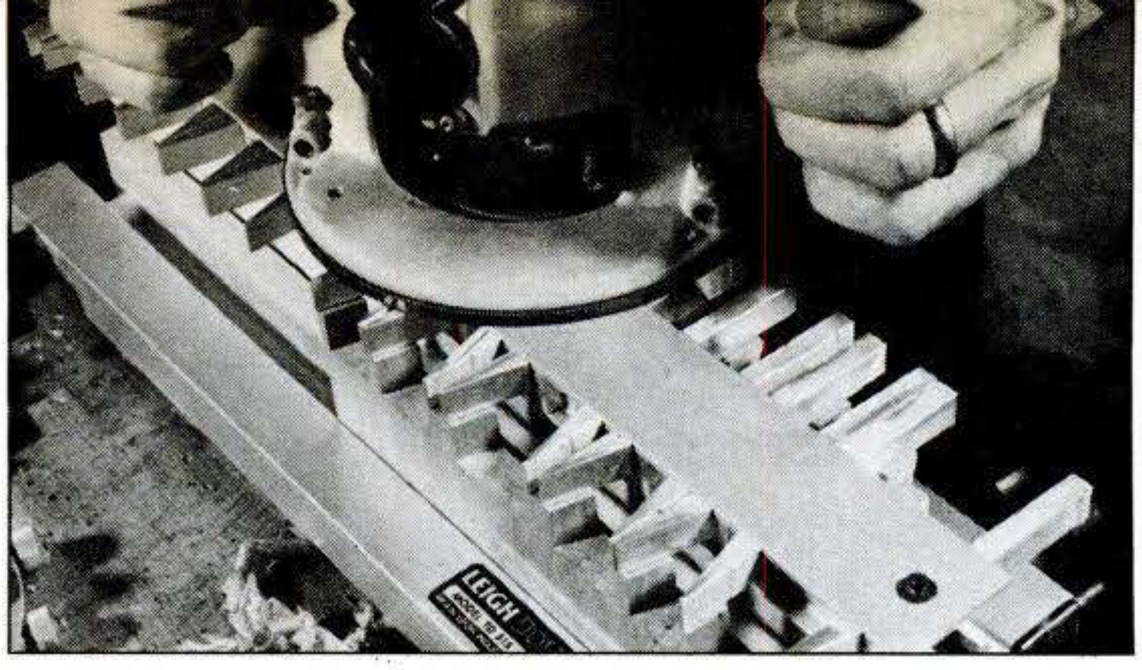
You can cut wood for hours without readjusting chain tension with the Halverson Auto-Tension chain-saw bar, says the maker. A spring-loaded tip maintains the proper tension, which means smoother sawing and less chance of kickback. A two-point oiling system helps prevent heat buildup, so the chain stays sharp longer. The spring-steel bar resists bending; if it does bend, you can reshape it by hand, the company claims. In idle, an automatic brake holds the chain. Sixteen-in. bar is $43.75; 18-in. bar, $45.75—in stores or from the maker, T & T Industries, Inc., Box 51, Spooner, Wis. 54801.

No-mess caulking

The Finish-It caulking tool scoops up excess caulking and creates a neat bead in one step, says the maker. The tool can be used in any 90-deg. joint. The tip can be trimmed to leave a variety of bead sizes. It's $2 from Sashco, Inc., 1395 S. Acoma St., Denver, Colo. 80223.

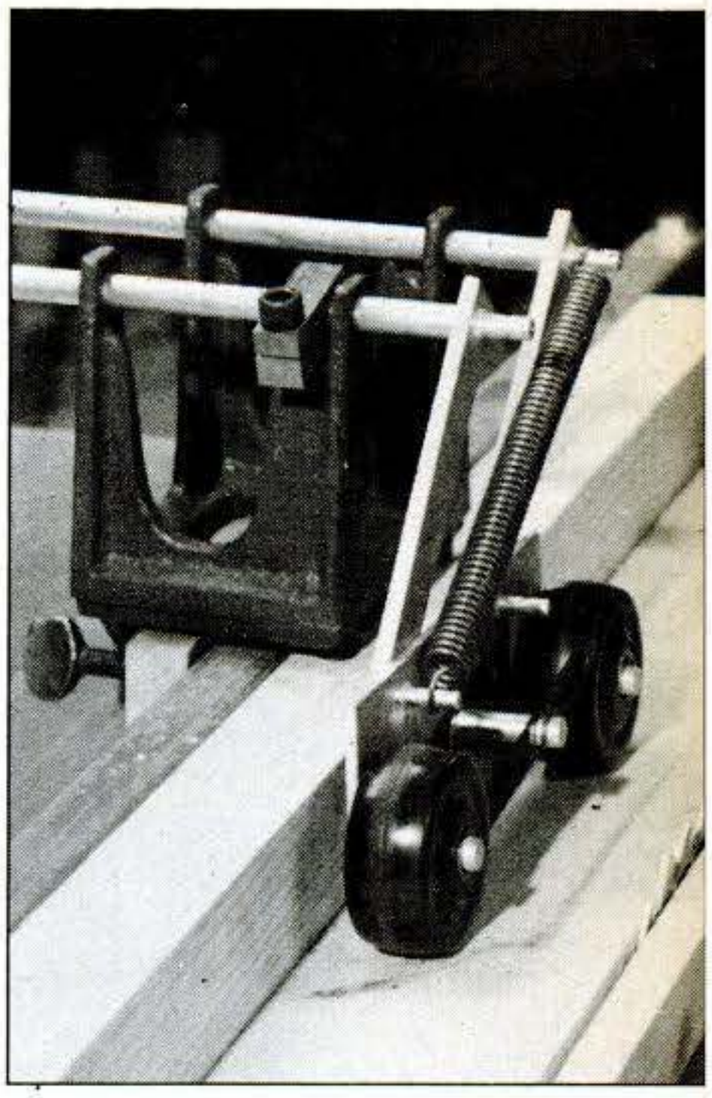
No-clean sprayer

A disposable paper cup is the paint reservoir for the Dockeen siphon-tube spray gun. You clean the siphon tube by spraying thinner through it. The gun is $40 from Aircraft Tool Supply Co., Box 475, Oscoda, Mich. 48750. It works off an air compressor—40 to 120 psi.



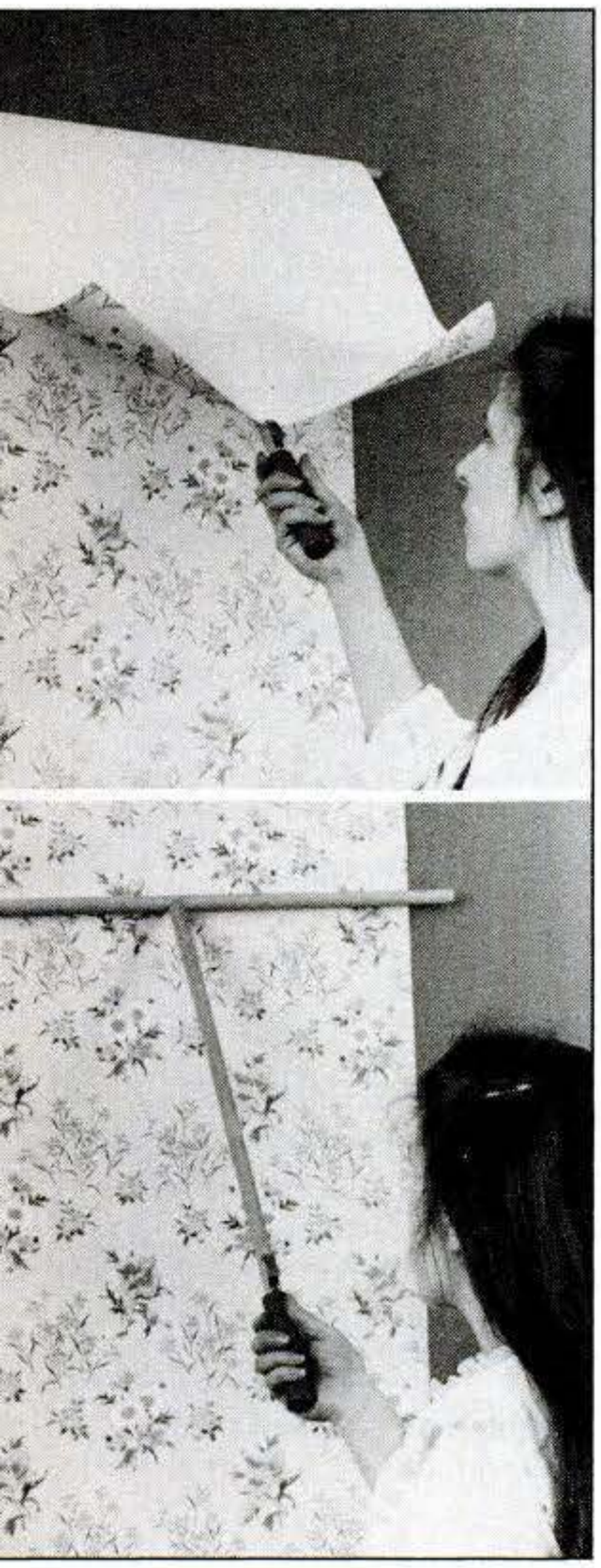
Dovetailer

You can cut through dovetails with a router and the Leigh Dovetail Jig. Pins are cut using the angled guide faces and a straight router bit, tails by using the square faces and a 15-deg. dovetail bit. Leigh Ind., Box 4646, Quesnel, B.C., Canada V2J 3J8. It's $150 (U.S.).



Finger sparer

Clamp Ripstrate to the fence of your table or radial-arm saw and its angled rubber wheels will hold the work against the fence, says Fisher Hill Prod. (Fitzwilliam, N.H. 03447). You push the work through with a stick. Ripstrate ($52.50 ppd.) also prevents kickback.

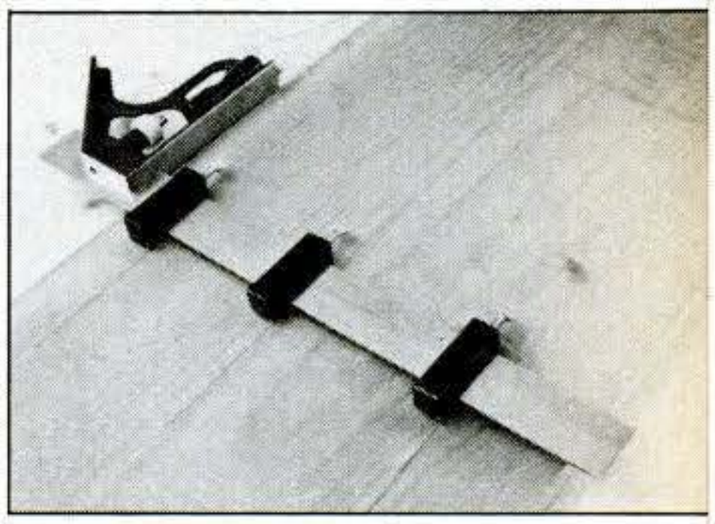


Folding horses

These sawhorses' legs fold up for convenient carrying and storage, lock open for stability in use. The Black & Decker Folding Sawhorses are 30 in. high and have replaceable fiberboard tops. The legs adjust for leveling. A single is $30; a team, $50.

Carbide scribe

You can do precise marking with your combination square and the Accuracy Plus scribe. The carbide tip marks metal, tile, and glass. Insert a pencil to mark wood. Scribes are $2.49 each or $6.49 for three from Forest Rivers Co., Box 657, Fall City, Wash. 98024.

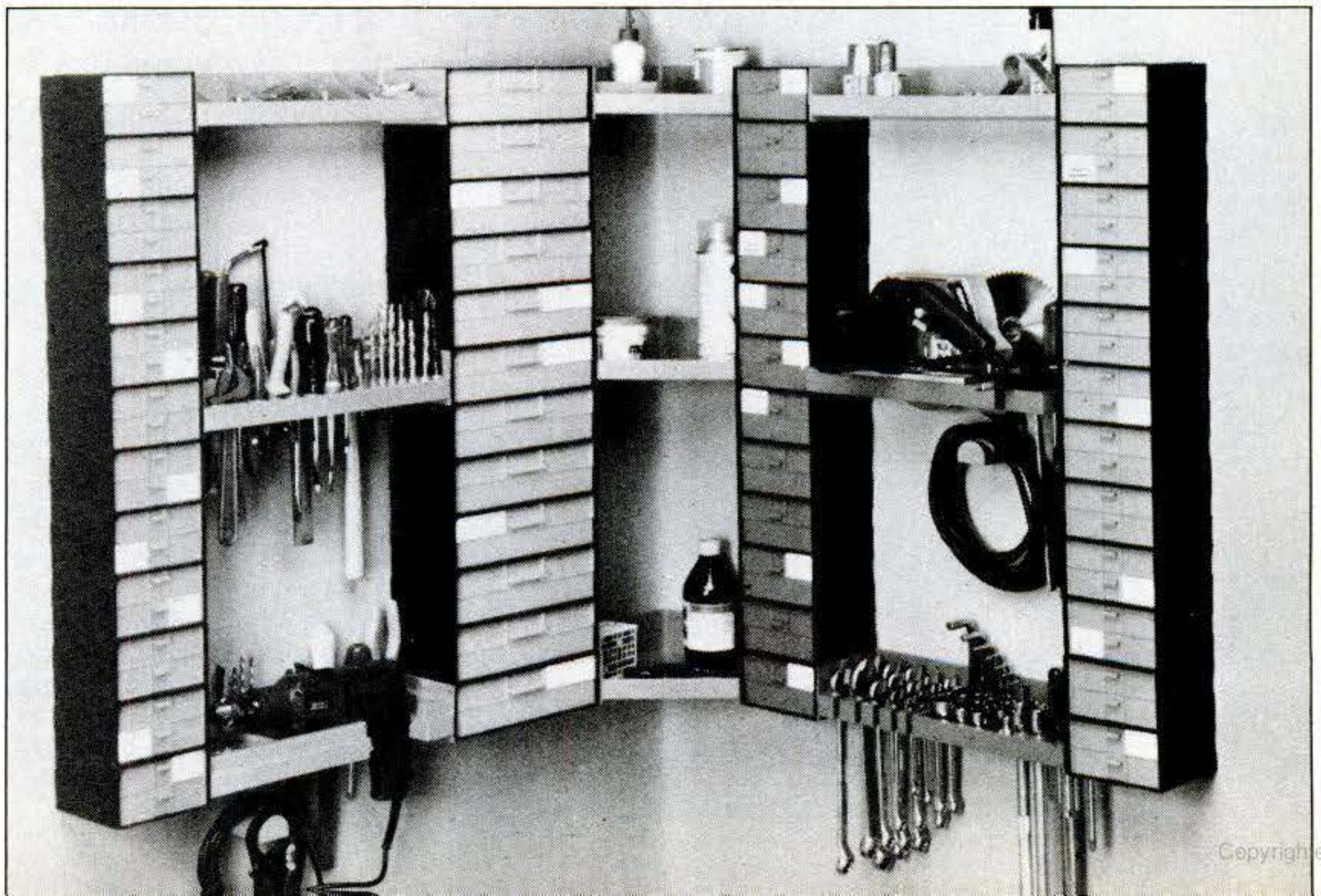


Paper carrier

Carrying pasted wallpaper is easier with the Paper Hanger's Helper, says Aqua-Tainer (55 Doris Ave., Joliet, Ill. 60433). A clip on the handle holds the strip (top). You align the paper, release the clip, slide the tool to the ceiling and then back down (above). Price: $5.50.

Ship-shape shop

With a combination of bins, drawers, shelves, and specialized racks (for hand and power tools) you can customize your tool storage. The Termotex Combi System is completely modular and can grow with your needs. Tencate Mfg. Co. Inc., Box 1245, Northbrook, Ill. 60062.



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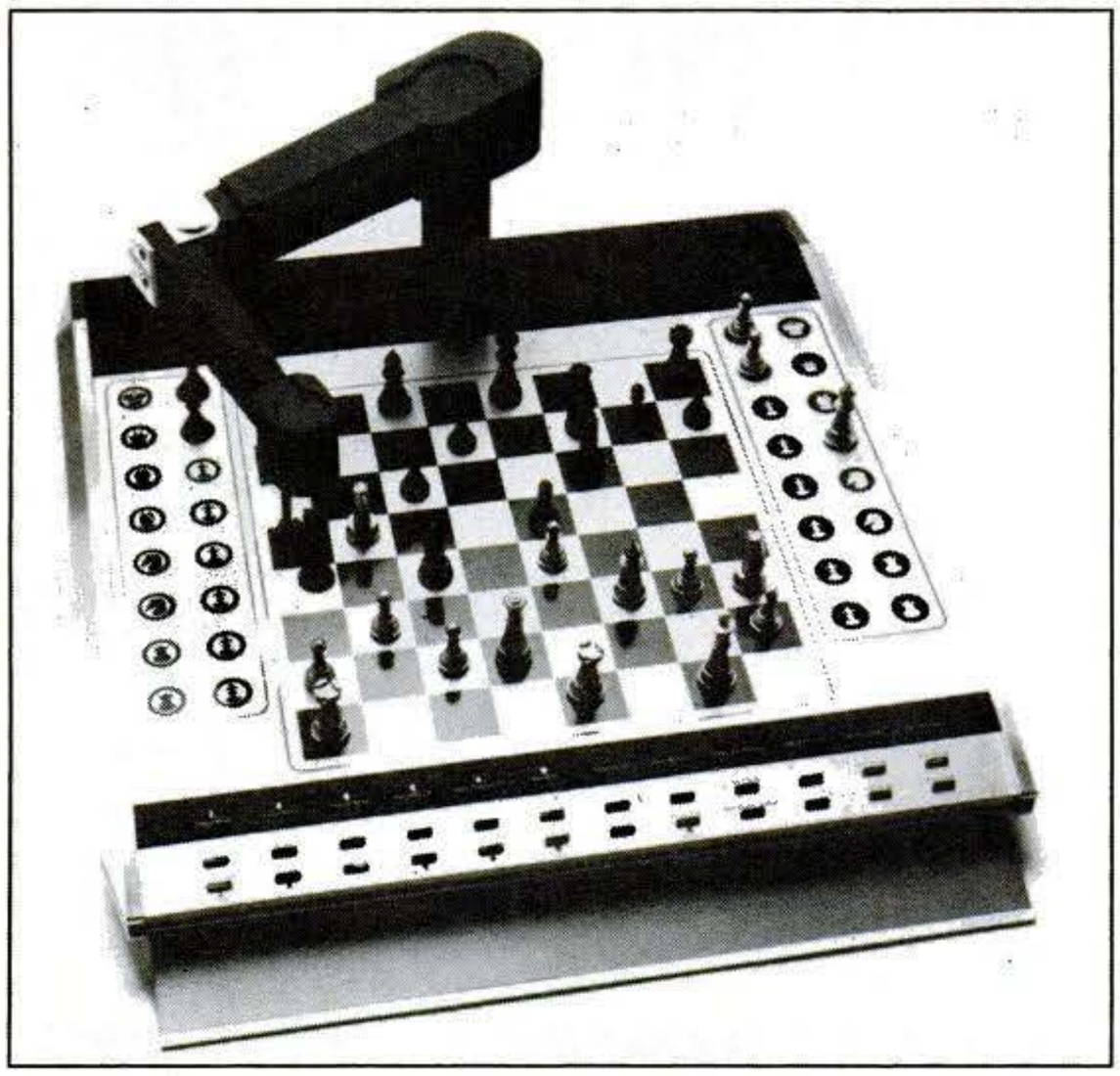
What's New IN ELECTRONICS

BY WILLIAM J. HAWKINS



Call screener

Connect PriveCode to your phone to screen all calls: An electronically synthesized voice answers, and only callers who know a three-digit code get through. You'll know who they are and who they want before you pick up. It's $495. IMM Corp., 150 Monument Rd., Bala Cynwyd, Pa. 19004.

Electronic drums

Tap one of those four pads and you hear an electronically created snare drum, cymbal, or one of two types of tom-toms. Not enough? Push those bottom buttons and you can create over 4,000 more drum sounds. Synsonics, by Mattel Electronics, is amazingly realistic. $119.

Nighttime LCD

Add state-of-the-art components to a clock radio and what do you have? The GE Model 7-4672. All its functions are instantly available by push button, and that digital display you see uses a *transmissive* LCD: It's lighted from the rear for viewing in the dark. $58.

Robot chess

Sure, you've seen microprocessor-controlled chess games before. But this one, the Robot Adversary, has a mechanical arm that actually moves the pieces on the board. It's distributed by Gavon/California Ltd., 3379 Cerritos Ave., Los Alamitos, Calif. 90720. Price: $1,400.

Videodisc player

Now, trimmed down twice, Pioneer's new Laser Disc LD-660 player is just 5⅝ in. high—and has a list price of only $600. The unit reproduces CX-encoded audio in stereo. Video controls allow freeze frame, slow motion, scanning, and step frame.

Speaking books

As they read, kids can slide the Magic Wand across bar codes printed on the page. Result: Words, songs, music, and sound effects are electronically reproduced by the Speaking Reader from Texas Instruments. A box with the first book is $120; other books, $12 each.

Auto talker

Just talk—the boom microphone automatically starts the Regency (7707 Records St., Indianapolis, Ind. 46226) walkie-talkie transmitting to a friend. Stop talking and you receive a reply. The $100 unit works in the 49-MHz FM range for communicating up to ¼ mile.

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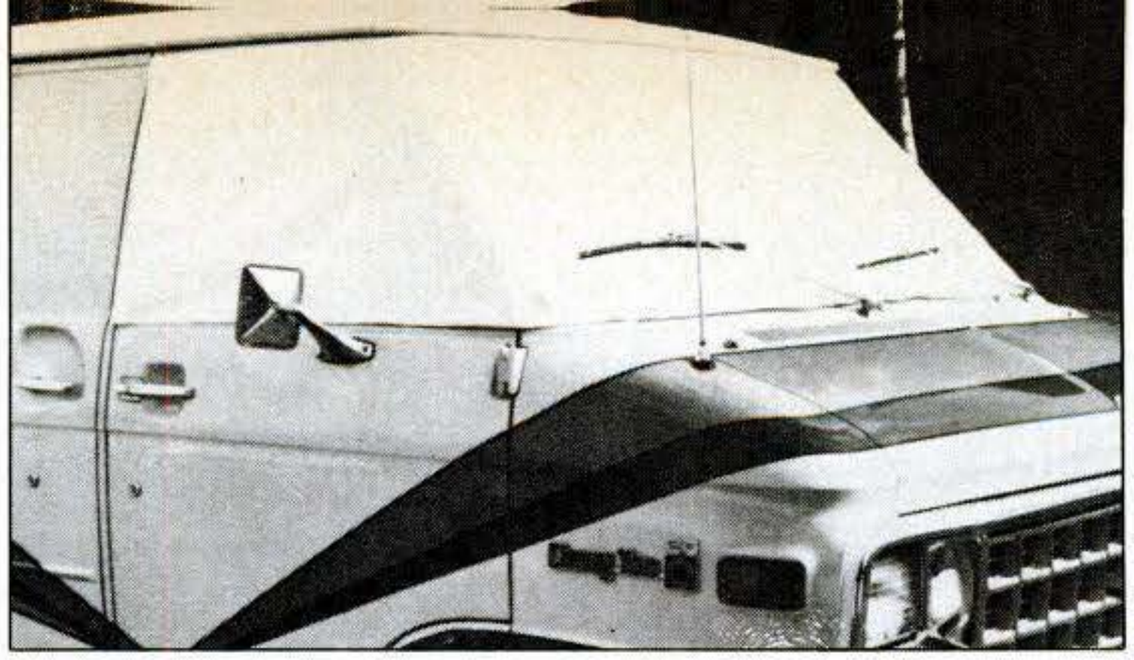
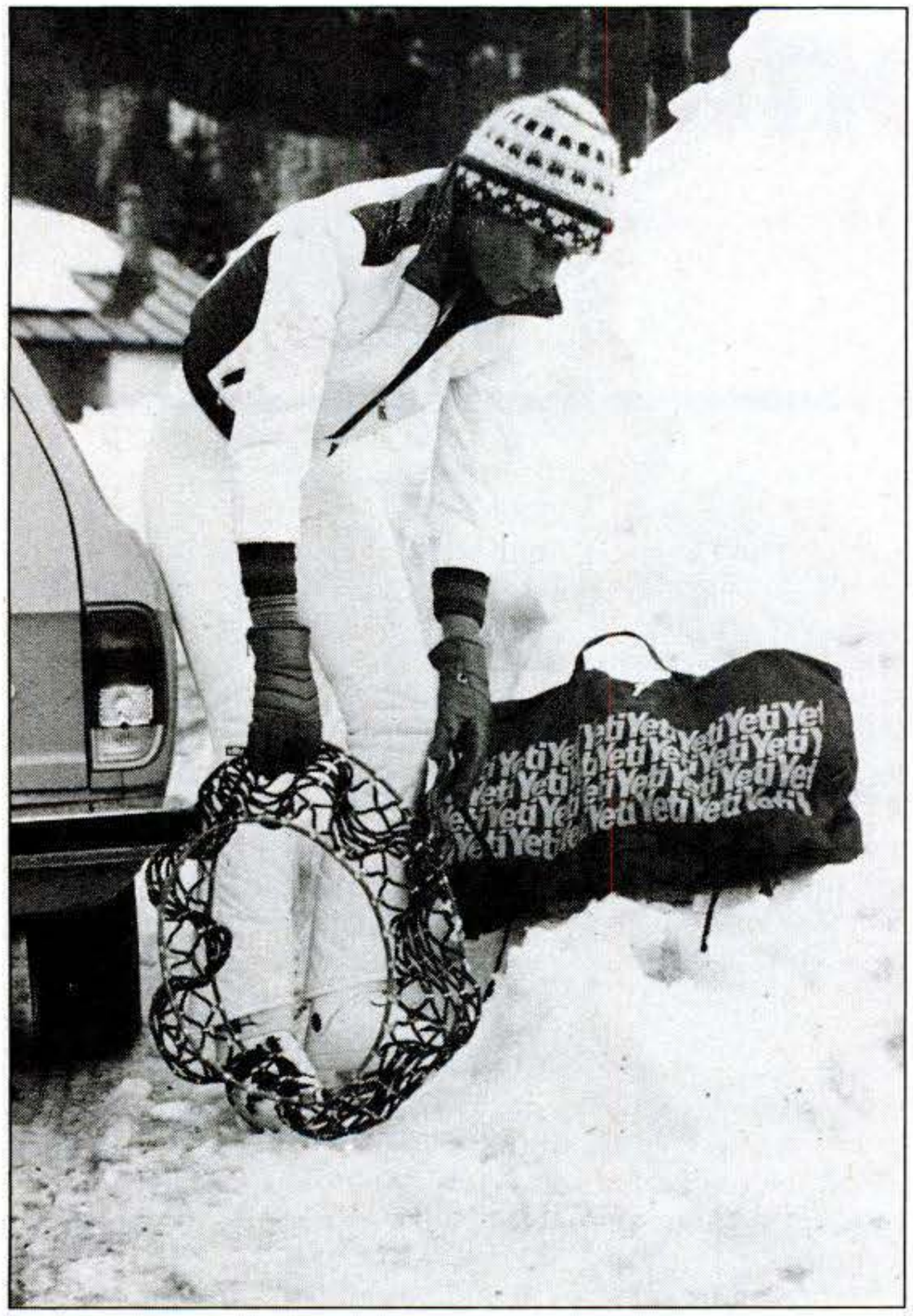
What's New
FOR YOUR CAR

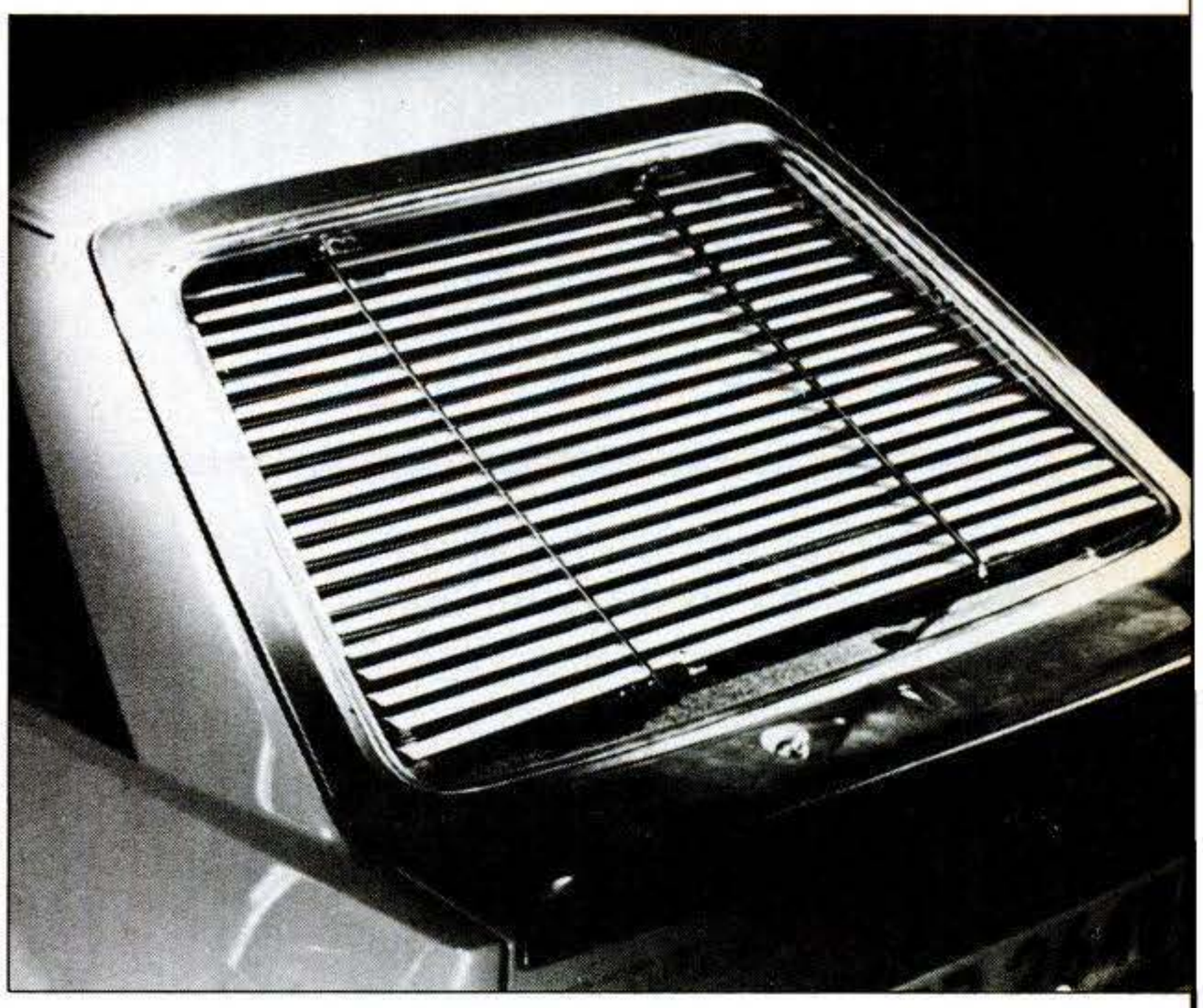
BY JACK KEEBLER



Cover-up

Sleep later with a cab cover that screens the windshield and side windows of your van or mini motor home. Magnets fasten it to your vehicle, and safety flaps that fit between the doors protect against theft. Price: $46.50. A & E Systems, Inc., 3100 Segerstrom, Santa Ana, Calif.



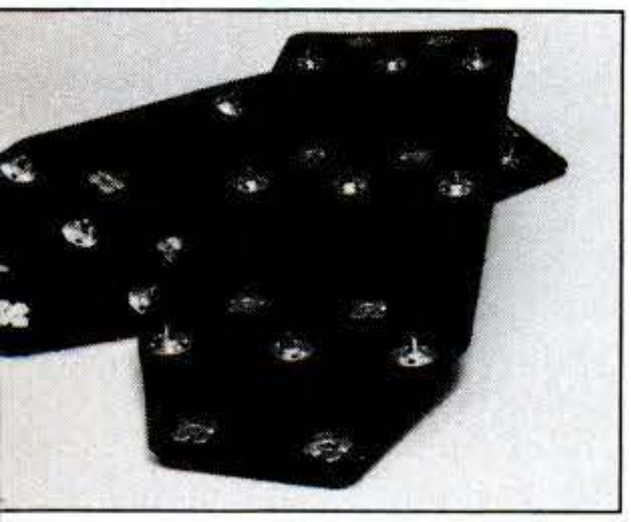


Rubber chains

Nonmetal snow chains won't damage your tires or the road, says the maker (Temset AG)—and they provide a quieter, more comfortable ride. Yeti chains are made of Du Pont Kevlar and rubber. Advanced Technology, 6265 Little Applegate Rd., Jacksonville, Ore., distributes them.

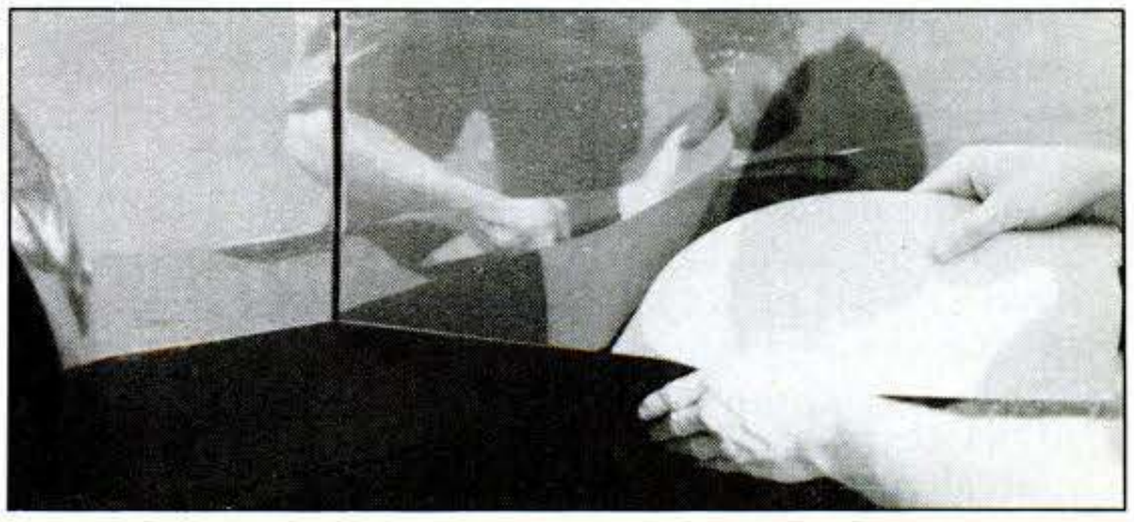
Electric blind

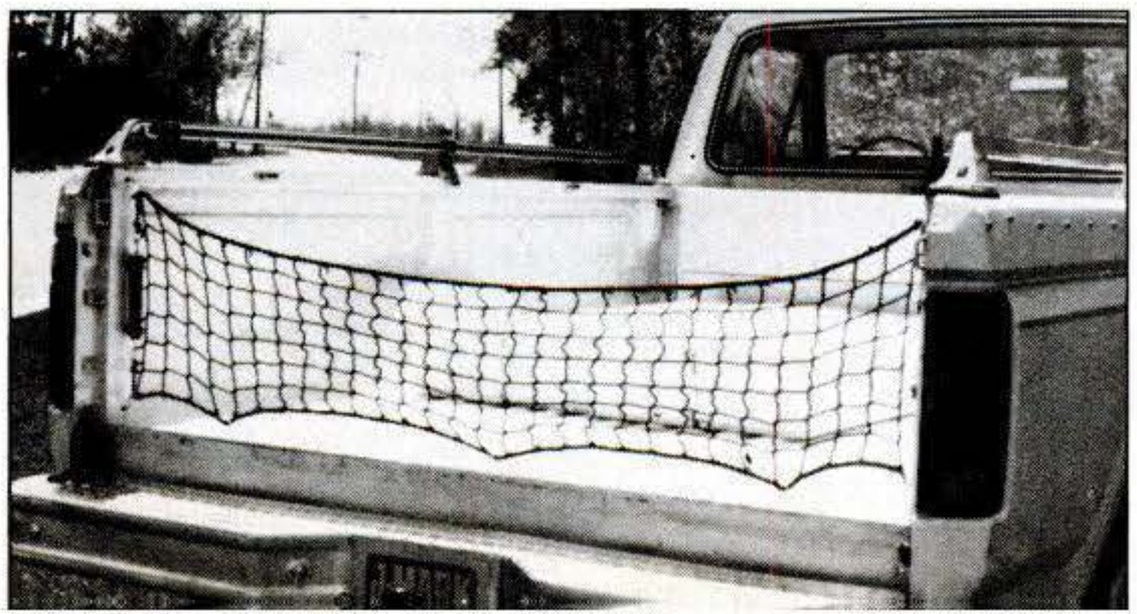
Available in white, gold, red, blue, yellow, or brown, this electrically operated Venetian blind is controlled by a dash-mounted switch. Hitrix Ltd. (Victoria Rd., South Shields, Tyne and Wear NE34 6EX, England) claims no drilling or cutting is necessary for installation. Price: about $80.



Traction aids

Don't get stuck on winter ice: These studded rubber strips stow in your trunk for those slippery situations. The studs are carbon steel, casehardened for long wear and zinc-plated for rust protection. Hycor, Inc. (10 Gill St., Woburn, Mass. 01801), makes them. Price: $15.





Low-drag gate

Using this net gate may improve highway mileage by 10 percent or more, says J-Mark (7373 Washington Ave., Minneapolis, Minn. 55435). The flexible nylon netting offers less wind resistance than conventional steel gates and increases range of vision when backing. Price: $22.

Panel protection

Is road gravel chipping away at your automotive investment? Textured, self-adhesive film protects car bodies from flying stones and road salt. It comes in clear or black vinyl from Trimbrite, Box 67, Holt, Mich. 48842. A six-by-72-in. roll of the nine-mil film is $13.90.

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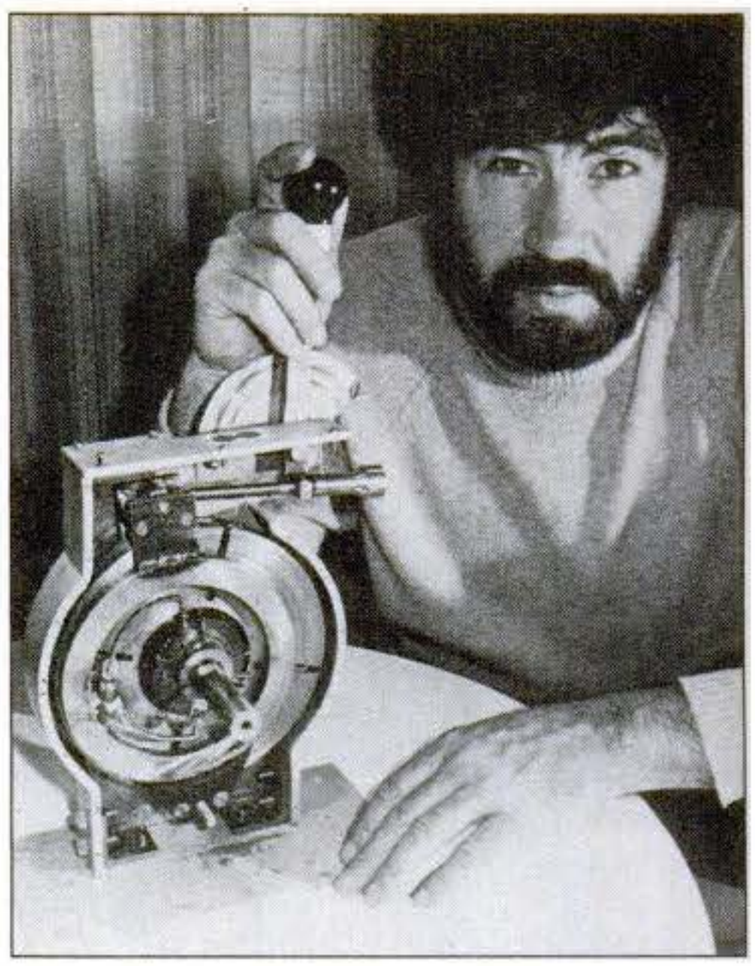
Cheaper, simpler, clutchless: cycloidal transmission



A stepless drive from an Australian mathematician provides an infinite ratio

By DAVID SCOTT
DRAWING BY RAY PIOCH

Imagine a continuously variable transmission (CVT) with no belts, traction rollers, or even gears, and an amazingly wide stepless ratio spread from super-high overdrive to a barely moving low.

Such a design won Eric Wilmott (photo above) a big cash prize on an Australian-TV inventors program, a Renault 18 GTS, and an all-expenses-paid trip to the recent International Inventors Exhibition in Geneva. At the Geneva show I puzzled long over one of the prototypes. The pancake-like device was only nine inches across and two inches thick, but according to Wilmott it could handle 25 horsepower and 140 foot-pounds of torque.

Wilmott moved the control lever to swing the motion-transforming rings concentric with the torque web. "That's the 1:1 ratio," he told me. "Try turning the input handwheel." As I did, the output shaft on the other side turned at the same speed.

"Keep turning and watch what happens when I move the lever." The ring swung increasingly off center, and I could see the output shaft slowing. "Full travel for maximum eccentricity on this model gives a 6:1 reduction," Wilmott said. Now the output shaft just crawled around, though with so much torque that I couldn't stop it from turning with my other hand.

The Australian grinned. "We're transforming circular input rotation into cycloidal motion, then back to circular for the output," he explained. "The ratio is changed merely by varying the shape of the intermediate cycloids."

How does the cycloidal transmission work? For a start, a cycloid is a curve generated by a fixed point on a circle rolling along a straight line without slipping. (You may remember this principle as it was applied in Kenner's Spirograph toy.) Continued rotation of the circle traces an endless series of connected loops, of which only the upper portions have perfectly circular form.

These true arcs always span at least a 90-degree sector of a circle. The principle upon which the CVT is based is that four of these cycloids in sequence could theoretically be cut off above the non-circular cusps and reassembled as the circumference of a new, larger circle.

"That's just what I do mechanically," Wilmott explained. "The fabricated circle is an intermediate motion element between the input and output shafts. To alter the transmission ratio, I change the effective diameter of the circle by stretching out or squeezing in the overlapping cycloidal arcs that form it."

The input shaft carries a rotating disc with four radial slots 90 degrees apart and an open center on the outer side. Wilmott calls this the "torque web." The output sleeve is coaxial with this shaft extension and has a toothed wheel that fits within the disc center.

The wheel is engaged by four coupling pawls that are fitted in the slots and rotate with the disc. They are free to slide in and out, and the radial positions of all four are controlled by a pivoting ring, called the "motion-transforming ring." This ring is composed of two identical sections flanking the disc. Each half has a circular guide channel that locates the bearings on either side of the coupling-pawl pivots.

Another important element is a pair of overlapping cams arranged to lift some of the spring-tensioned pawls off the toothed wheel while the wheel is being driven by other pawls. This is a critical function. "They control the period of individual engagement and cut out the non-circular bits of the cycloidal cycle that I don't want," explained Wilmott.

"Ratio is controlled by the degree of ring displacement from the center shaft. The geometry can be arranged for overdrive at one end of its swing," Wilmott continued. "Move the ring the other way and you glide back past 1:1 into very deep ratios like 1,000:1. Then the output shaft barely moves, but with tremendous torque. A bit more and it stops, though the input shaft is still turning.

"That's the neutral point, when the pawls are angled to grab the toothed wheel at a dead-center radial position. Now the torque web contributes nothing to forward motion. In a car this would de-couple the engine without any clutch."

What are the snags? One could be the clickety-click of the reciprocating pawls at high speeds. Another problem is pawl switching, which causes intermittent coupling between the input shafts causing a slight (0.5 percent) cyclical speed variation rather than constant velocity.

Given Eric Wilmott's creative genius, these problems are small, and without question we'll be hearing more about this unique transmission in the near future. PS

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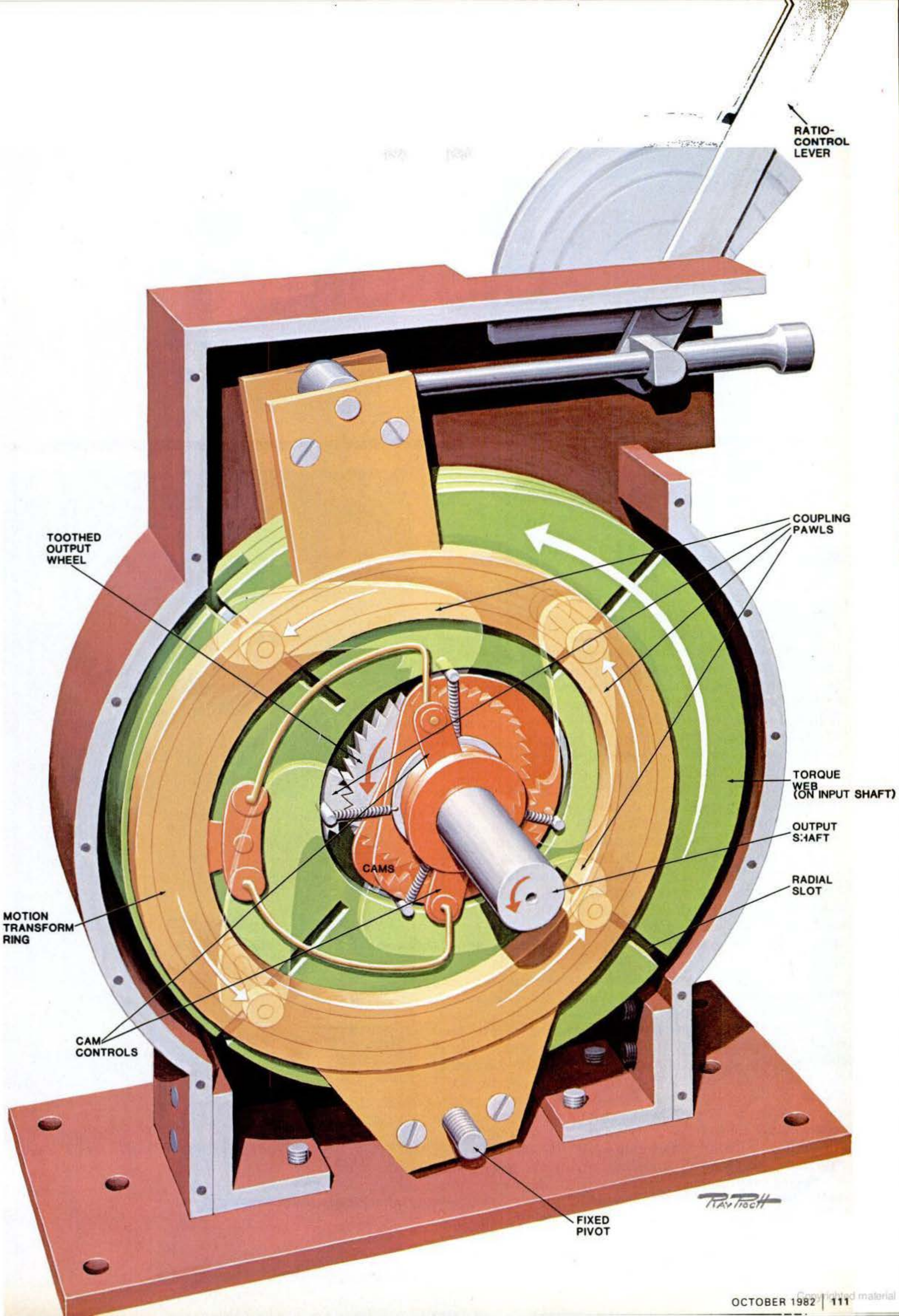

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Two-zone biosphere

On chill days, close off the living room and bedroom above it to save heat; the remaining house is cozily livable

By AL LEES COLOR RENDERINGS BY BILL PHILLIPS

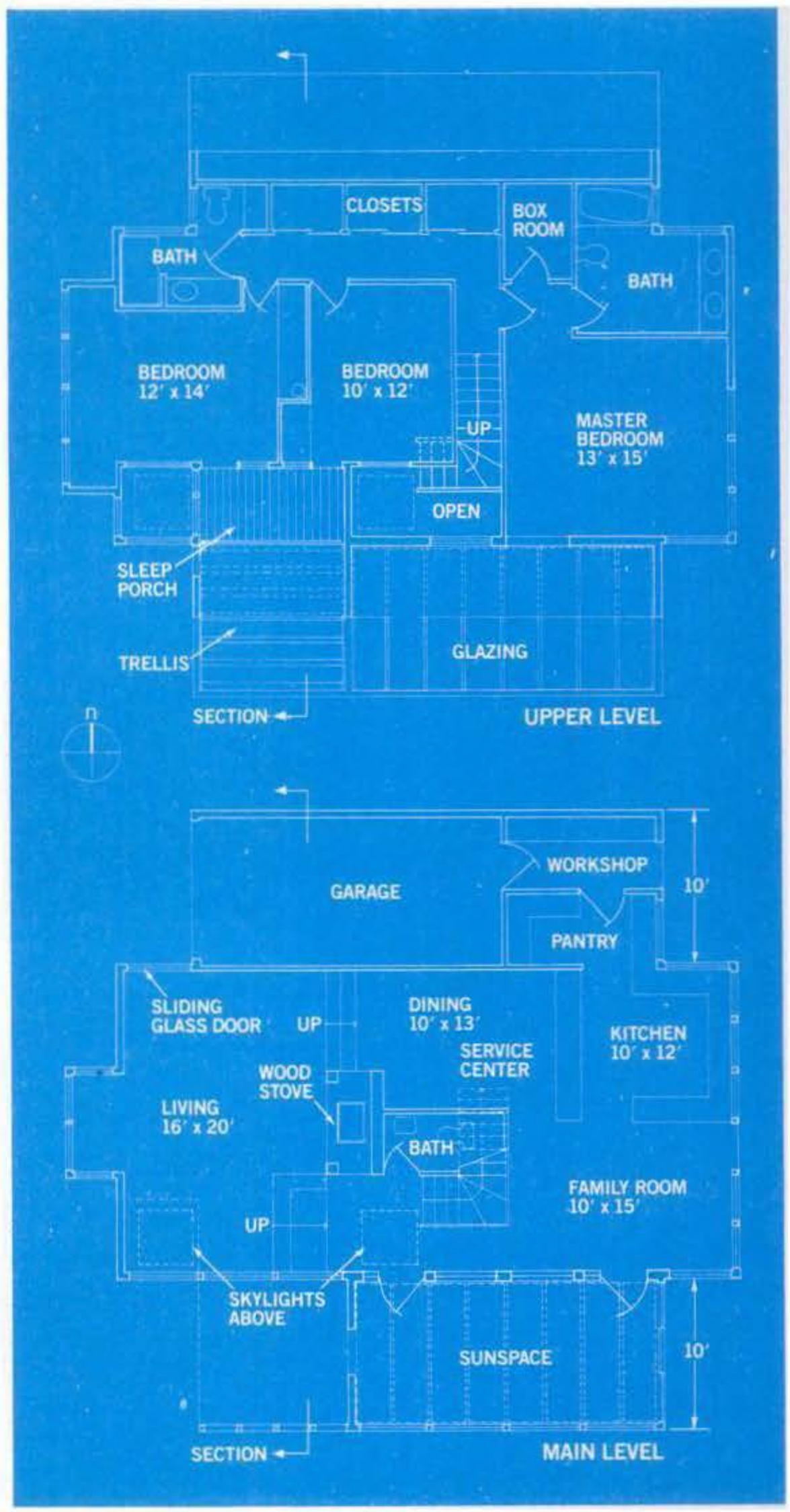
This lively house can be zoned for all seasons. The glazed west wall, with its stacked bays (paired windows and sidelights topped with a broader four-window bay), gives onto the living room below and a bedroom above. When fewer people use the house on a chilly weekend, you can close off both of these rooms: Tall insulating panels, hinged to fold compactly, can slide across the top of the stairs to butt the wood stove's masonry enclosure; an insulated metal shutter can drop in front of the operating wood stove so that its heat moves out the side openings and radiates through the rear wall of the enclosure. On bright days the sunspace collects heat and shares it with the living area. At night (or on dull days) it is closed off from the house to avoid heat loss: You shut the doors and draw insulating shades.

For summer use, of course, the complete house is opened to the free flow of fresh air and is ablaze with light. To prevent overheating you'd want insulating shades on the most exposed south windows, including those behind the sunspace. With these simple zoning adjustments, this "biosphere" remains self-sufficient in either warm or cold weather.

In the floor plan, note that all interior doors are indicated with the conventional swing-arc symbol. All exterior doors are shown as a single solid line. There are three (not counting the overhead garage door): one between the entry trellis and sunspace, and two on the east wall—at the rear of the workshop and in the family room. The sliding glass door that opens from the living room onto the apron of the garage is a convenience option, to avoid walking around to the entry after parking in the driveway. You'd have to provide steps up to it, of course, from the sunken floor.

That floor is dug into the earth to add variety to the open plan and to provide a 12-ft. ceiling for this handsome room. A two-story skylight shaft at one corner adds further dramatic impact.

The "box room" off the master bedroom is a walk-in closet that could also be used for bulky storage—or even as a darkroom, sharing plumbing with the adjacent bath. The other bedrooms share access to a sleeping porch. PS



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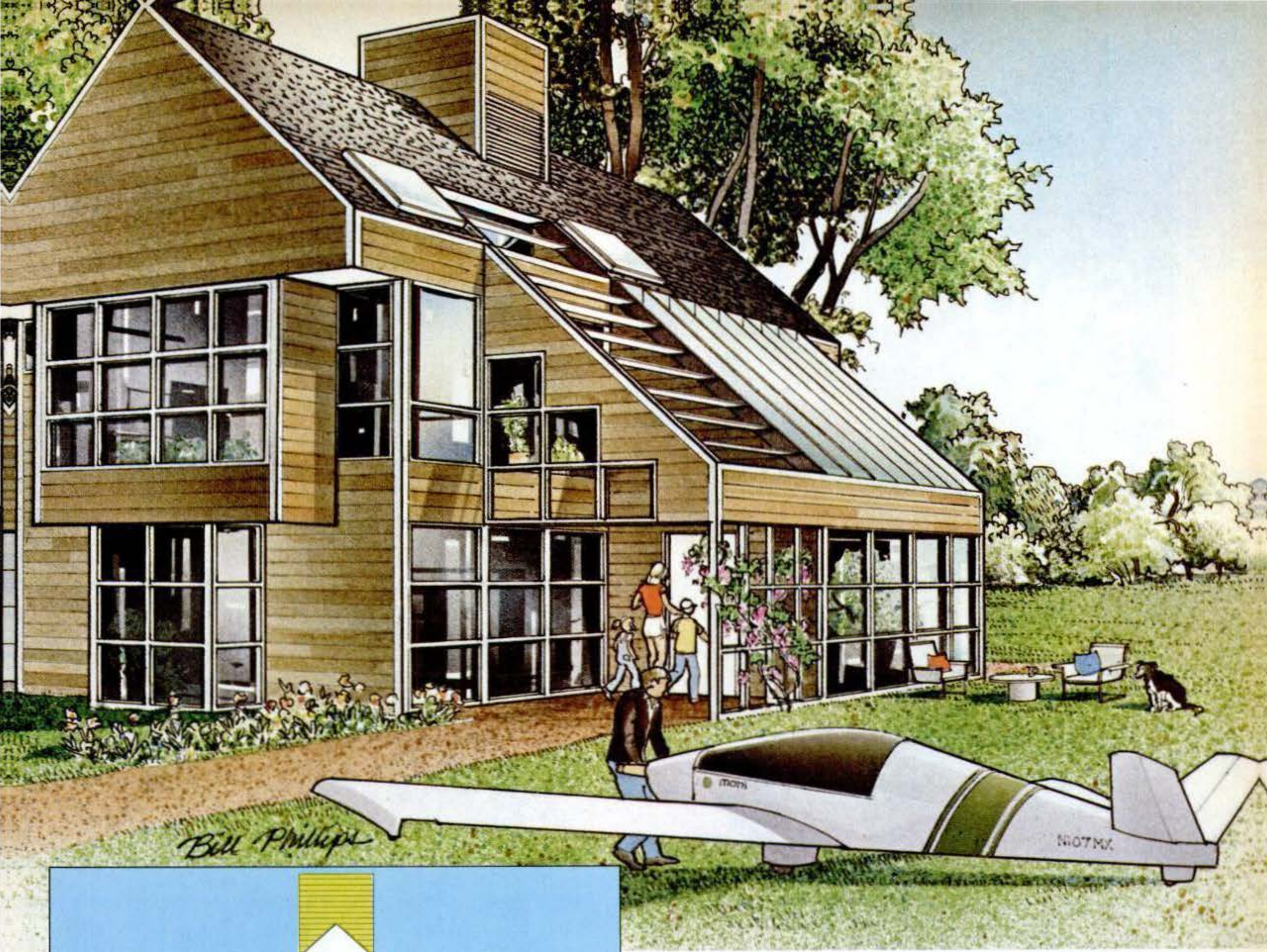
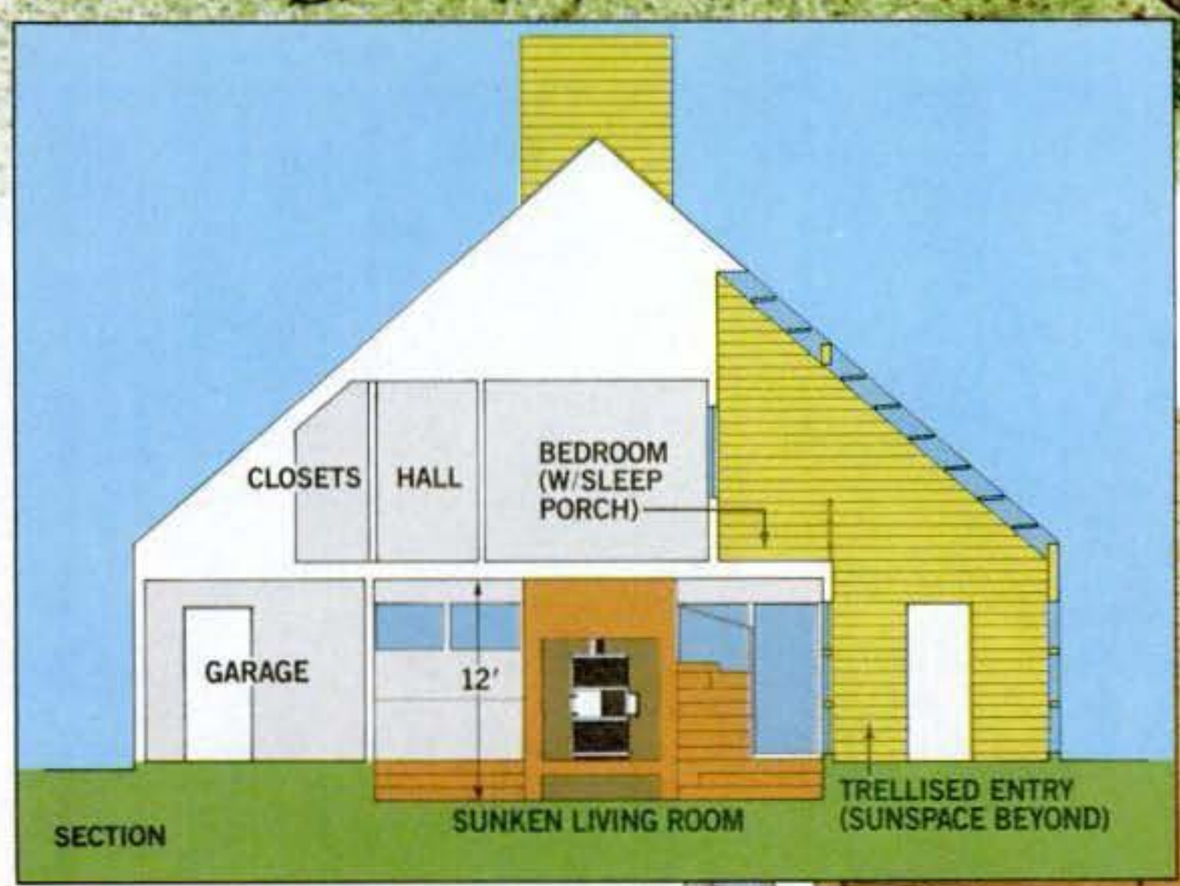
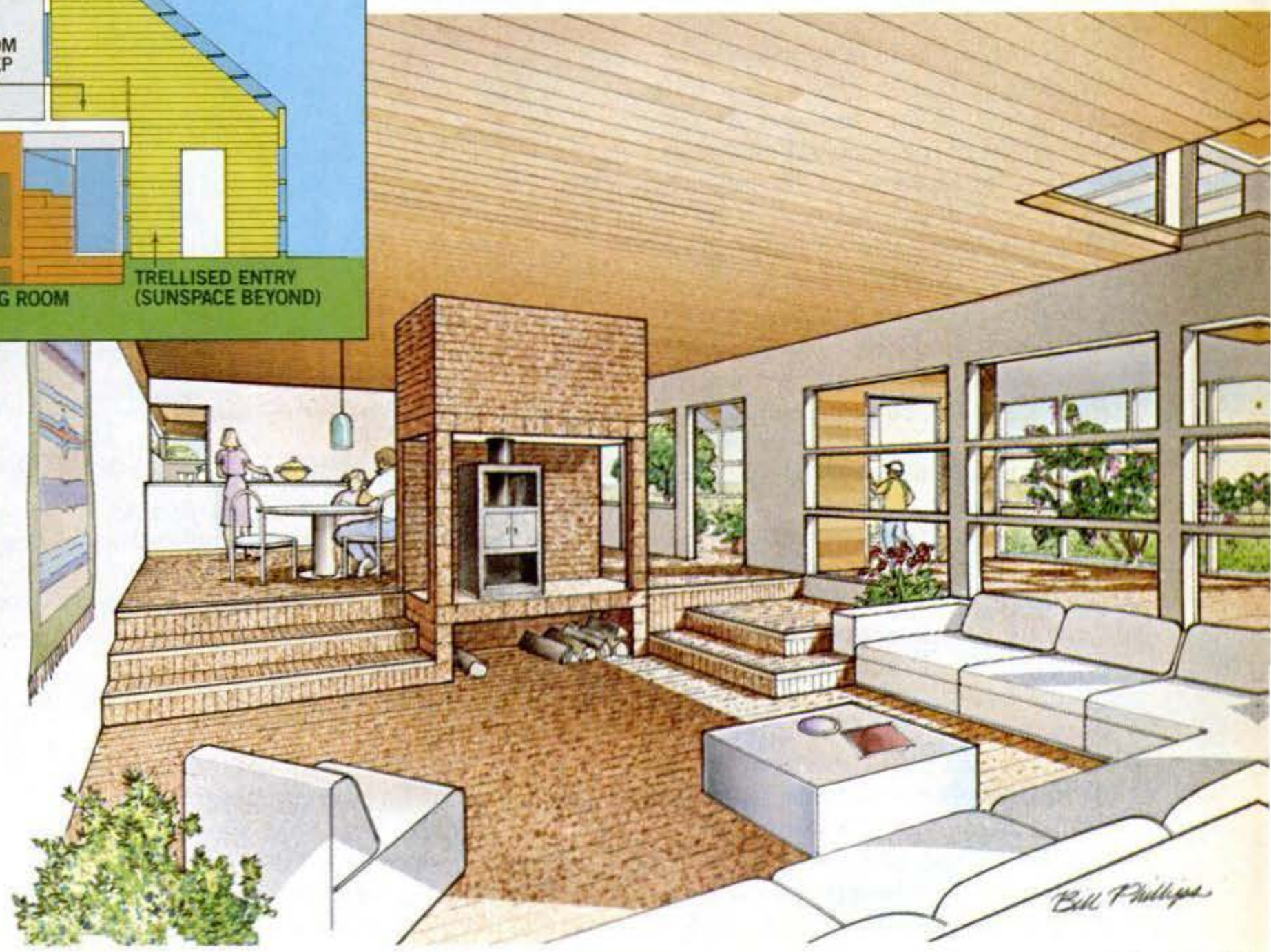




Section through house (left), at point indicated by arrows on floor plans, shows how living room is sunk two feet into ground for added interest and ceiling height. Slatted canopy admits low winter sun to entry area but screens summer heat.



How to order your plans

For architect's working drawings of this house, send your check to Alfredo De Vido, 699 Madison Ave., New York, N.Y. 10021. A single set is $100; four sets are $125. A complete materials list is $10 additional. Three other De Vido designs appear in *Popular Science Leisure Homes*—a book of 56 of the best plans in this series. Send $18.95 to Van Nostrand Reinhold Mail Order, 7625 Empire Dr., Florence, Ky. 41042.

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Solar One

Sun, to heat, to electricity

A forest of mirrors in the desert makes history as sun-powered turbines roll

By JIM SCHEFTER

The glistening field of mirrors caught the desert sunshine. Over 1,800 heliostats, sprawled in a fan-shaped array covering 70 acres, focused on the central receiver, a 45-foot-tall metal cylinder atop a 300-foot tower.

Minutes later, the cylinder glowed white hot in the shimmering air, and the world's largest solar-powered electrical plant made history. Solar One produced its first high-pressure, 700-degree-F steam, rolled the blades of a turbine generator, and sent electricity coursing into the power grid near Barstow, Calif.

Solar One is a $141 million pilot project, designed and built by the McDonnell Douglas Corp. The 10-megawatt plant, operated by Southern California Edison under government contract, is to go through a five-year test program. But already the concept seems solid enough to spur Edison into planning for a 100-megawatt plant—to be on line by 1988.

Solar-thermal technology does not convert sunlight directly into electricity as does a photovoltaic cell. Instead, heliostats—steerable mirrors—reflect and concentrate sunlight onto a single steam (or other vapor) generating target. The steam turns power-producing turbines.

With power off, beams from mirrors converge in space (top). When focused on receiver (above), sunlight generates steam to power turbines on the ground.

Since that first test last spring, a few problems have cropped up, including dead heliostats that won't track the sun, unexpected thermal gradients, and some buckling of the panels in the central receiver. The system was designed, however, to produce full power even with as many as 32 heliostats out of operation. Heat stored in rocks and high-temperature oil can produce power for four hours.

By the end of 1983 an automatic control system should be operational. With a crew of no more than four people, Solar One will automatically start each morning, run during the day, and shut down each night. PS

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HOME HEATING SECTION

Kerosene heaters

—the safest type yet is one you must *install*

Latest version of the controversial kerosene heater is vented to the outdoors for goof-proof operation

By AL LEES

A third generation of kerosene heaters should do much to dispel the clouded reputation that has clung to this widely used but often feared appliance. The unit being installed in the photo on the next page—a Monitor 30—answers most objections to old-style portables: It can't be tipped or moved too close to flammable fabrics; since it's vented, it won't burn up the room's oxygen supply; and it won't be improperly fueled once attached to its own outdoor tank.

Though more than 10 million households will buy kerosene heaters of various types through 1985, there are still homeowners who shudder at the very mention of them—and several states and cities still ban their use. Why? Because through improper use people still manage to kill themselves with kerosene heaters.

The fact is, according to the National Kerosene Heater Assn. (NKHA), there's no record of a single death or house fire caused by any modern kerosene heater, properly used. The bad reputation, NKHA insists, originally came from cheap, old-style units that were dangerous and smelly. It persists because of a few careless but tragic errors where users fueled one of the newer heaters with gasoline.

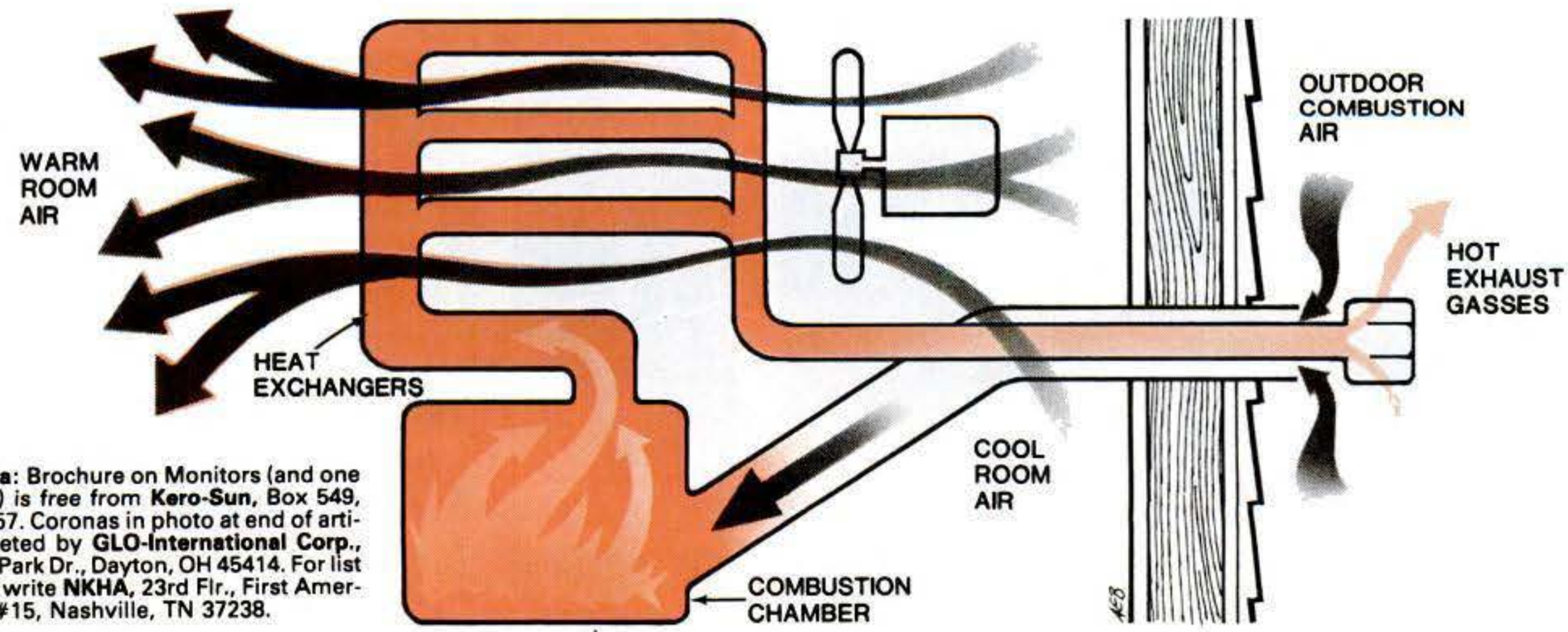
In these second-generation portables, pressureless wick-type systems draw kerosene from a tank placed as far away from the combustion chamber as the size of the heater permits. If the flame goes out, the fuel won't feed. (All heaters made or imported by NKHA members are UL listed.)

But the new permanently installed vented heaters are intended as complete heating systems—ideal for room additions, converted garages, and attics. Last year, Kero-Sun (an innovator in this field that, ironically, declines membership in NKHA) introduced its Monitor 20, which preheats outdoor air for combustion as it exhausts byproducts (diagram below). It has push-button start-up, as well as a clock timer for automatic turn-on.

Now Kero-Sun has just introduced a bigger brother, labeled Monitor 30. It has a 13,000-Btu-greater heating capacity (32,600 compared with the 20's 19,600 rating) and offers new fuel-tank options that avoid the refilling nuisance: You can install a 55- or 275-gallon outdoor gravity-feed tank—or even a full-season underground

Continued

Diagram below shows how vent system being installed, next page, will work. Outside air is drawn in (around warm exhaust pipe) for combustion. Heat travels into series of heat exchangers; fan behind these draws in room air to blow through them.



For more data: Brochure on Monitors (and one on portables) is free from **Kero-Sun,** Box 549, Kent, CT 06757. Coronas in photo at end of article are marketed by **GLO-International Corp.,** 3975 Dayton Park Dr., Dayton, OH 45414. For list of portables, write **NKHA,** 23rd Flr., First American Center #15, Nashville, TN 37238.

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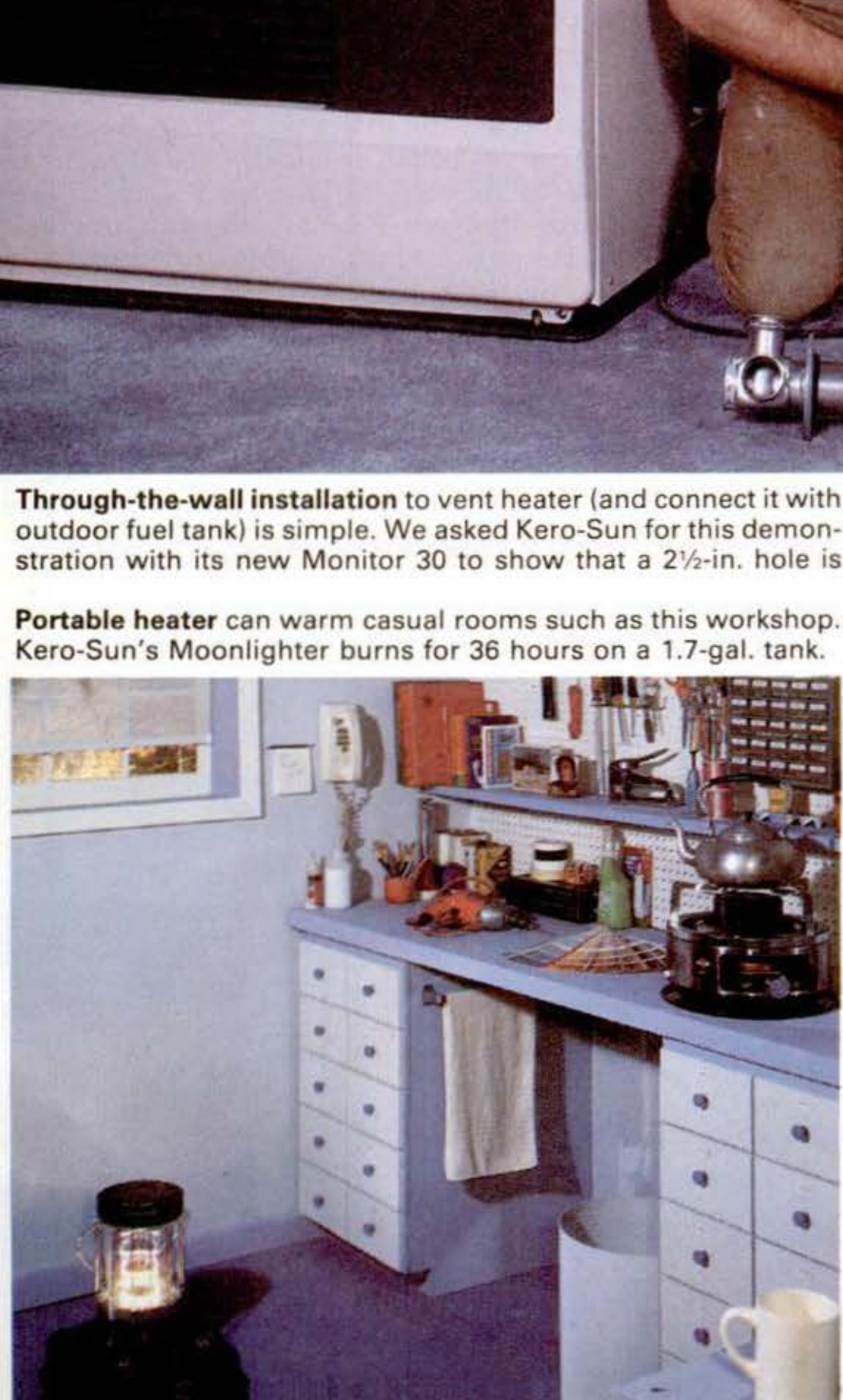
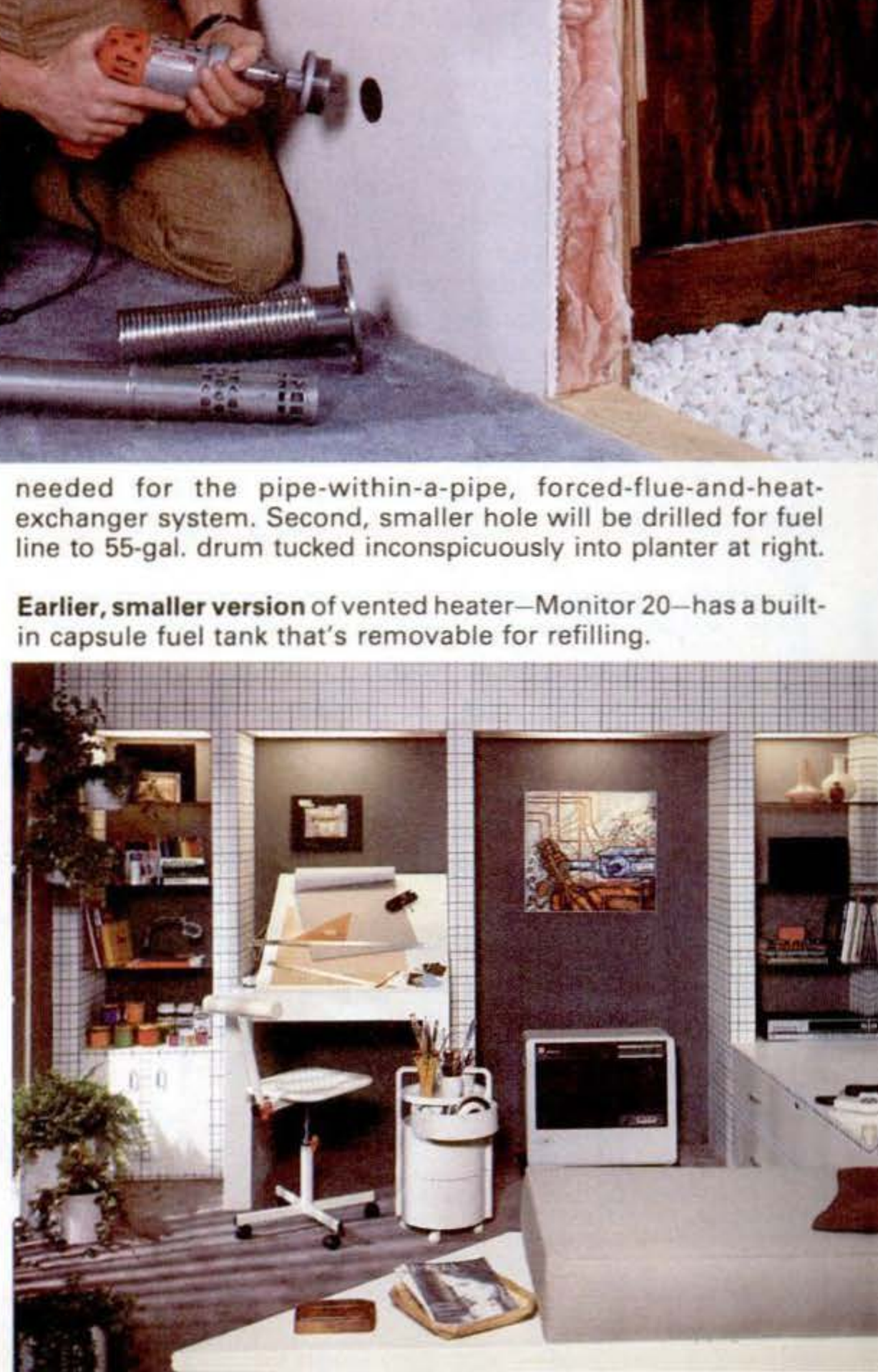
Through-the-wall installation to vent heater (and connect it with outdoor fuel tank) is simple. We asked Kero-Sun for this demonstration with its new Monitor 30 to show that a 2½-in. hole is needed for the pipe-within-a-pipe, forced-flue-and-heat-exchanger system. Second, smaller hole will be drilled for fuel line to 55-gal. drum tucked inconspicuously into planter at right.

Portable heater can warm casual rooms such as this workshop. Kero-Sun's Moonlighter burns for 36 hours on a 1.7-gal. tank.



Earlier, smaller version of vented heater—Monitor 20—has a built-in capsule fuel tank that's removable for refilling.



tank. Timing mechanisms can automatically turn the heater on and off twice a day. Both Monitors claim a 92 percent fuel efficiency. (Venting does lose you a little: Most portables claim over 95 percent efficiency.)

Kerosene heating appliances are rated in size by the number of Btu they produce per hour—from 5,000 to over 30,000 Btu. To select the right size for a room, measure two walls to determine your square footage, then multiply that by 28 to get the rough Btu output needed. Prices range from $180 for a small portable to $989 for Kero-Sun's Monitor 30 (the Monitor 20 is $850).

Both vented heaters shown on our color page could be installed in an hour or two. Just drill a 2½-inch-dia. hole through an outside wall as shown. After mounting the vent-pipe assembly, drill a smaller hole for the fuel line and set the heater in place. PS

Portable kerosene heaters: Use with care

According to NKHA, imports on kerosene heaters climbed from 3,500 in 1974 to 3,154,000 in '81. The great majority of these new heaters are unvented portables that lack the features of the installed types. There are cautions you should consider before buying a portable.

The typical new portable is a compact unit with safety switches to shut it off if it's tipped or jarred (a carry-over from their Japanese origin, where the switch was required as an earthquake precaution) and a burner designed for safety and efficiency, using a wick that absorbs fuel by capillary action, located above a non-pressurized tank.

Most renewed interest in kerosene heaters has been spurred by energy conservation. The heaters are efficient: Almost all the fuel that's burned is converted into heat. But these units really come into their own when used for "zone" heating: You simply turn the central-heating thermostat down and use a kerosene heater to heat the room you are using. Savings can be spectacular.

Despite requirements for boldly printed decals on these heaters, many users ignore safety precautions such as proper ventilation. Due to the near-total combustion, emissions are low and odors are kept to a minimum, so it's easy to forget about oxygen depletion. In a well-sealed room, these heaters can lower oxygen to a dangerous level. NKHA and some manufacturers suggest opening the door to an adjacent room. Others recommend cracking open an exterior window. If you locate the heater under the window, you'll get no draft.

Never fuel these heaters with anything but water-clear kerosene. No substitute will do—not aviation fuel, or No. 1 fuel oil, or "dirty" kerosene. It's especially important to guard against putting gasoline in the heaters. Store your fuel in a metal container clearly marked KEROSENE—and it shouldn't be a red can that could be filled with gasoline by mistake. Never refuel a heater indoors or when it's hot, and don't let children do the job.—*Evan Powell*

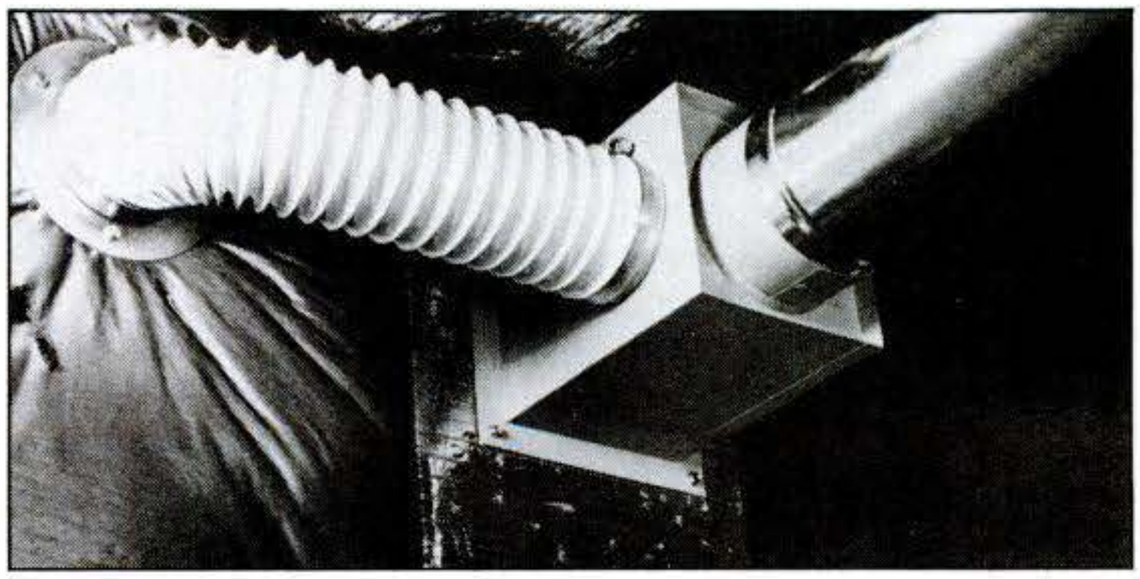
Air controller
compensates for negative pressure

Negative pressure. These words describe a costly and potentially dangerous condition in your home. Use any appliance that exhausts air to the outside—anything from a bathroom fan or dryer to your fireplace or furnace—and it draws air from the inside. If your home is "loose," air is sucked in through cracks and windows to make up the difference in pressure. But on well-insulated, or "tight," homes, negative pressure develops: Appliances become starved for air, and that causes inefficient, expensive operation.

One cure: Skuttle's Make-Up Air Control. The temperature-operated version mounts on the return-air side of the heating system and connects to an outdoor air supply through four-inch tubing and a screened hood. A bypass tube attaches to the warm-air side of the furnace.

When the furnace blower starts, warm air flows through the bypass tube. And when the temperature rises, an adjustable heat-sensitive coil opens a damper in the intake-air duct. Fresh air flows in and is filtered, heated, and humidified before entering the living area.

According to Greg Costley, engineering manager at Skuttle (Marietta, Ohio 45750), the sizing of the two temperature-controlled units is based on average residential requirements. Model 204, shown below, is for furnaces up to 150,000 Btu; model 206, over 150,000 Btu. The adjustable bimetal coil allows further tailoring for individual homes. But the lower temperature levels of heat pumps probably won't actuate the unit. For those installations, a barometric control is used (model 216). It can be adjusted to open only if negative pressure exists. All models are available nationally from heating and air-conditioning dealers. No suggested retail prices are available, but in my area I was quoted $50 to $60 for model 216 and $70 for 204 and 206.—*Evan Powell*



Air-controller kit contains bypass tubing, fittings, screened intake hood—but not intake tubing. Manual control knob on side of unit can be locked in open position for fresh air when central air conditioner is running. Installation (right) is simple: Use control flange as template and cut hole with tin snips. Air inside this home seemed noticeably fresher after unit was installed.

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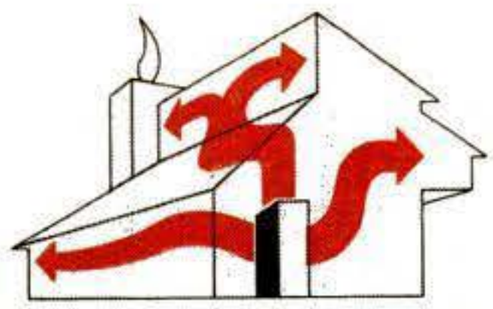

Installing a wood stove? First:

Reline your chimney

Cheaper than a new chimney, relining makes your leaky chimney safe

By MARK BITTMAN

Facing another winter of rising fuel costs, many homeowners rebel.

"I'll buy a stove, hook it up to the chimney somehow, and switch to wood or coal."

This nonchalant method of installing a solid-fuel burner may save the homeowner some money, but it could result in massive creosote buildup—and a devastating chimney fire.

Creosote can be controlled by following a few simple procedures (see box), but a properly lined chimney is an essential starting point. An efficient liner not only discourages creosote buildup, it also keeps flue fires confined to the chimney.

The cost of a new liner? It can vary from about $250 to almost $2,500, depending on the method chosen and on the length and configuration of the chimney. (Prices given here are for a 25-foot-high, straight chimney.) A new chimney usually costs at least $3,000.

When does a masonry chimney need relining?

Most, if not all, chimneys more than 20 years old need a new liner. A large, old, cracked chimney may work fine with an open fireplace, in which high temperatures, strong updraft, and frequent feedings are the rule. But that oversize flue will produce a weak draft for a solid-fuel stove. Gases and particulates won't rush up and out but will have time to linger, cool, and condense, forming creosote buildup.

Lowering Super-Flex liner, professional installers hop to it. Novices would be well advised to keep both feet on the roof, though tube is fairly easy to handle.

A poorly lined masonry flue also has plenty of cracks where creosote can nestle. If there's a chimney fire, these cracks may allow sparks and flames to escape, setting the house afire.

A new liner can be tailored to fit the stove. Proper sizing allows for a good draft and a warm flue, which combine to rush byproducts out of the chimney. This is not only more fuel efficient, it—and the liner's smooth surface—cuts down on creosote. And since a new liner has no cracks through which flames can escape, if a chimney fire did occur, it would pose less of a threat to the house.

The first step in relining a chimney is to make a thorough inspection of the chimney's interior and have it cleaned. Professional help is the key here, even if you're planning a do-it-yourself relining job.

A chimney sweep can measure the chimney accurately, and he may find minor bends that would preclude using any liner designed for a perfect-

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ly straight chimney. He may also discover structural flaws that need to be corrected.

Ceramic liners

Ordinary, pipelike flue tiles can be used for relining jobs even if the chimney has a slight bend or two. But you must have masonry skills or be willing to hire a mason. You'll have to mortar around the close-out door and stovepipe connection. And the tile sections themselves must be joined with mortar or furnace cement to ensure a good seal. This usually means that you'll have to knock a few holes in the chimney, reach in to mortar between tiles, then patch up the brick.

If you have a perfectly straight chimney, the Acu-Set inflatable tool can simplify the job. The tool sets premortared tiles in place (see diagram, next page), aligning them for a truly positive seal. At $550, only professionals (or a group of neighbors) will want to buy an Acu-Set tool, but you may be able to rent one.

All liners, especially those in exterior chimneys, can use insulation. The insulation helps keep the flue warm, and a warm flue means less creosote. So after installing flue tile, insulate the liner by pouring vermiculite between it and the chimney. Or you can seal the gap between chimney and liner at top and bottom to create an insulating dead-air space.

Steel-lined chimneys

Most homeowners who do the relining job themselves choose to install stainless-steel liners. (Don't confuse these with flimsy, aluminum-clad stovepipe.) Stainless-steel liners vary in structure, installation procedures, and price. Three typical liners with do-it-yourself applications are reviewed here; there are others. Renew-A-Flue ["What's New in Home Improvement," PS, Nov. '81] was the first stainless-steel liner to be marketed aggressively. It's designed specifically for homeowners and, given perfect circumstances, can be installed in several hours. A basic kit for a 12-ft. chimney comes in diameters of either six or eight inches. The basic length may be extended by liner sold in two-ft. sections. Three different insert connector kits are available, so a variety of installations is possible. To line a 25-ft. chimney costs between $400 and $500, depending on chimney design.

Renew-A-Flue sections snap together, which is undeniably convenient. But once joined the sections can't be separated, so don't goof.

Saf-T-Liner, another steel-liner kit, is comparable in design and cost. Saf-T-Liner offers four flue sizes—from five to eight inches in diameter. The liner sections must be screwed together before installation, making a more secure connection than the Renew-A-Flue. Saf-T-Liner also has a few more choices of elbow sections for use with angled chimneys than does Renew-A-Flue. But both systems lose their major advantage, which is simplicity, when used in anything but a straight chimney.

Homeowners with offset or extra-tall chimneys may want to consider Super-Flex, a flexible stainless-steel coil that comes in 25-ft. lengths costing $550. This system, which was designed over 50 years ago, may offer the easiest and most secure installation available to the do-it-yourselfer.

Depending on chimney height, you either cut the coil to proper length or join sections using slip connectors and rivets. Then the liner is just lowered down the chimney. For a chimney with multiple bends, a helper below can tug gently on a rope attached to the liner's bottom. Or the rope can be fastened to a sheet-metal cone that's secured to the liner's bottom. Pulling with steady tension on the rope makes installation literally a snap.

Once installed, Super-Flex is anchored on top and bottom with stainless-steel plates. (A similar flexible steel liner known as Z-Flex comes with a stainless-steel chimney cap.) Again, insulating with vermiculite or dead air is recommended.

Can you hook up a stainless-steel liner to any solid-fuel burner? While nobody questions its suitability for a wood burner, some problems have arisen with coal burning. Gases given off by burning coal often form hydrochloric and sulfuric acids that may condense on flue pipes, forming a corrosive substance known as smut. Smut can pit and even perforate some stainless steel.

Saf-T-Liner comes in a ceramic-coated version that's said to prevent smut buildup. Makers of other steel liners say the steel is durable enough to withstand smut as long as the flue is checked and cleaned regularly.

Professional jobs

A professional can install any of the stainless-steel liners, as well as flue tiles. And there are some methods of chimney lining that can be done by qualified professionals only. These are usually chimney sweeps who hold the local franchise for nationally distributed systems such as the form-and-fill method called Supaflu, Readi-Flu, or Permaflu.

Installers first clean the chimney and seal all openings. Then they lower

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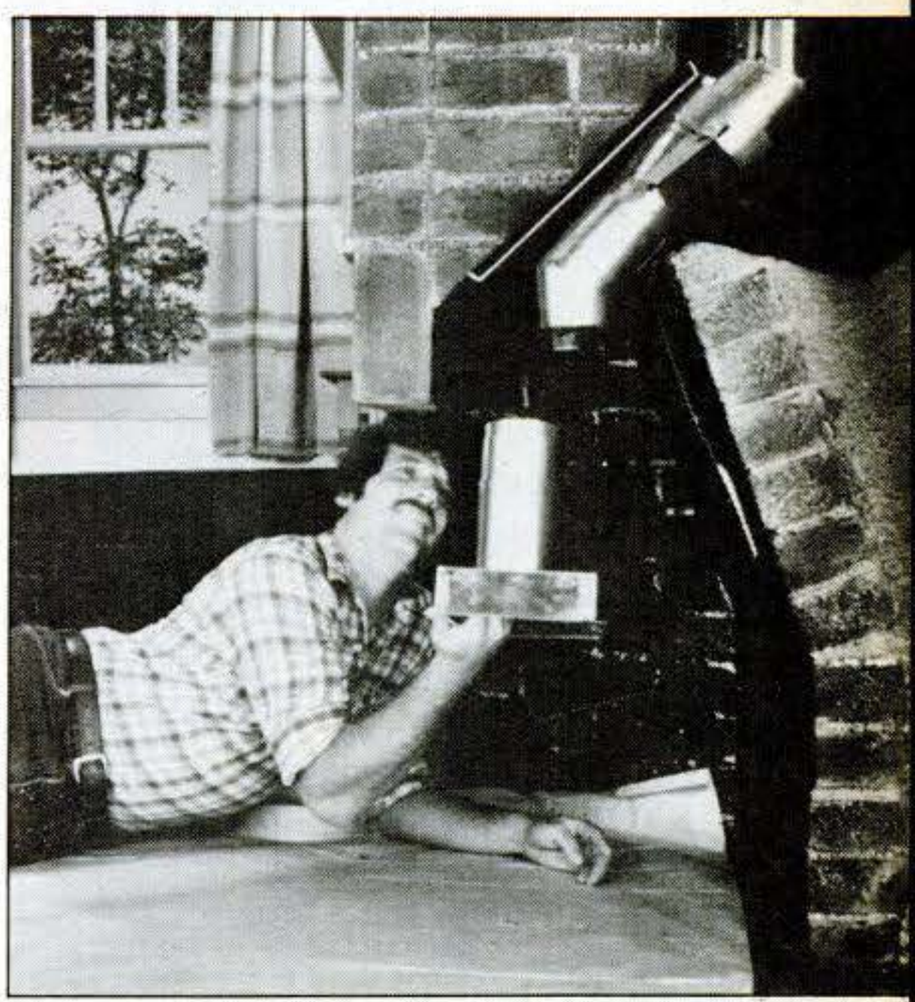

Snap-together Renew-A-Flue sections (top) must be carefully assembled before lowering into chimney (here cut away to show installation process). Connector kit linking liner to stove snaps on from below. A through-the-wall kit is also available.

Drilling holes in Saf-T-Liner sections, then screwing them together, takes time. But it makes for a secure connection that can't shake apart in a chimney fire.

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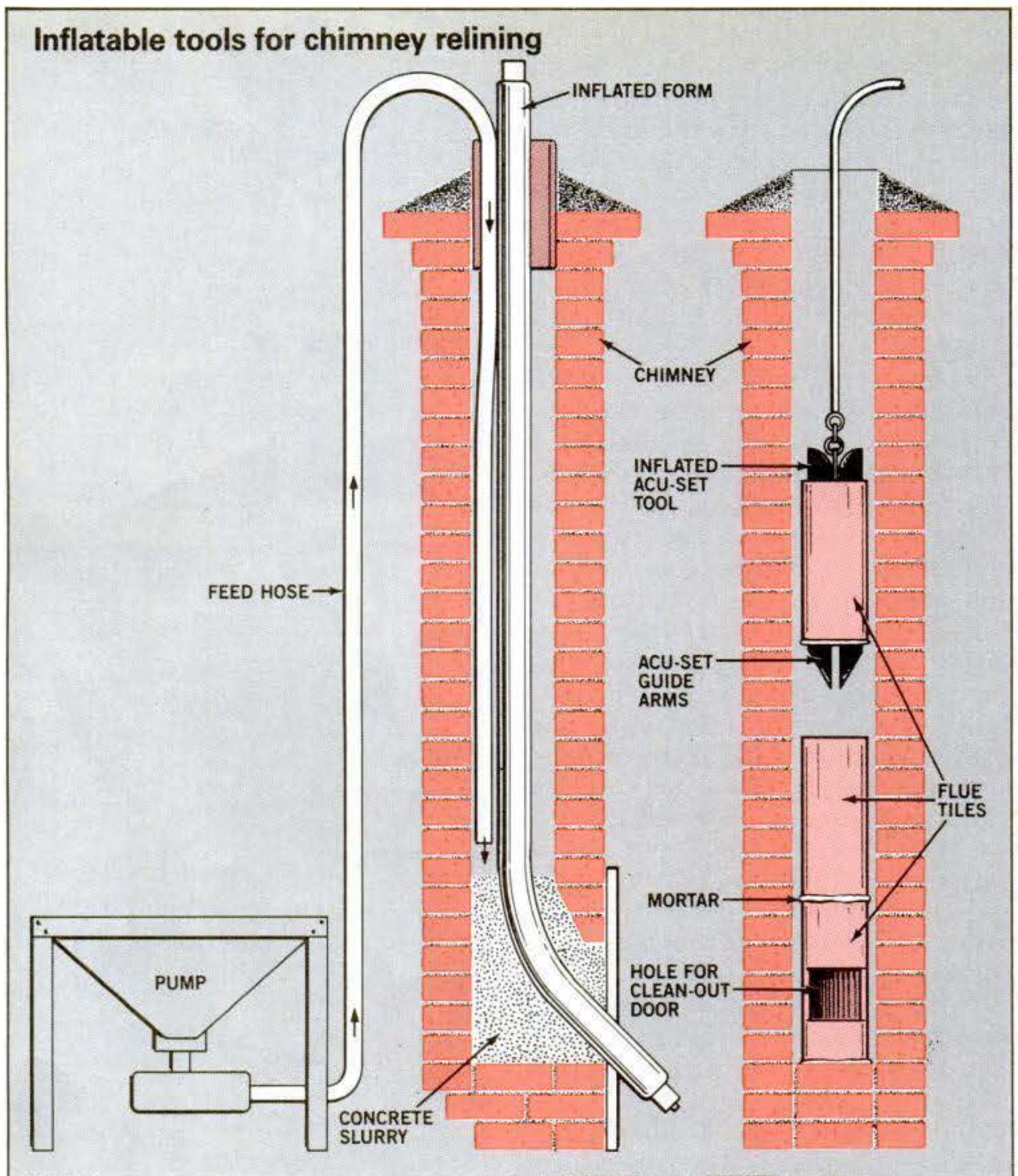
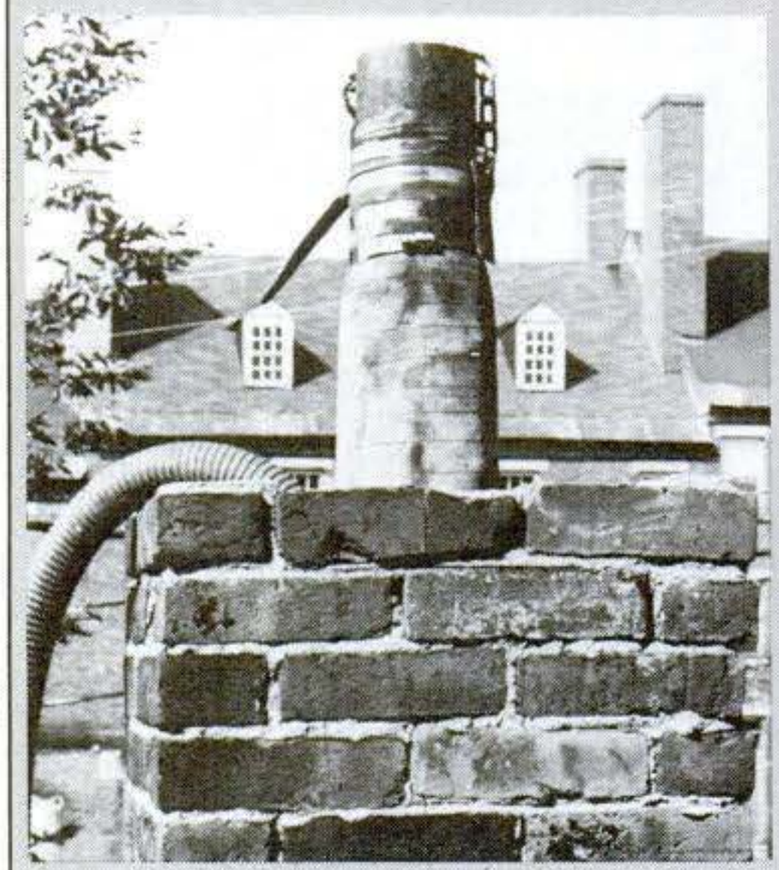
Inflatable tools for chimney relining





Flexible form-and-fill tube (at left in diagram above) conforms to chimney bends. After tube is braced in place, it's inflated to the proper size for the new flue opening. A feed hose is inserted between tube and chimney (photo above) and a masonry slurry pumped in. After slurry hardens, tube is deflated and withdrawn. Result: a strong new masonry liner like the Permaflu installation shown in cutaway. Another inflatable tube, the Acu-Set tool (at right in diagram) eliminates a lot of masonry work. Slipped into a pre-mortared flue tile, the inflated tube grips the tile as it's lowered. Guide arms help align new tile.

a flexible tube, inflate it, and pour a slurry of cement, vermiculite, and stainless steel down the chimney (see diagram). This process costs between $700 and $800.

One advantage of form-and-fill liners is that they give strength and support to old masonry chimneys and may add years to their lives. In addition, the compound is designed to act as its own insulator. Finally, chimney angles present little problem to the flexible tube former.

The $800 Ventinox system also has a form—a stainless-steel liner that remains in place after the concrete and vermiculite mixture is poured. Again, insulation is provided and the chimney is strengthened. The stainless-steel liner adds protection in the event of a chimney fire.

The Iso-Kaern ("insulated core") system is a third variation. The liner is solid pumice. Once it's lowered into a straight chimney, a cement insulating mixture is poured around it. This system is marketed to the builders of new chimneys, but its durability makes it a good reliner. It costs about $550 for a 25-ft. chimney.

Unfortunately, the national safety codes for chimney liners are outdated and inadequate. Some manufacturers seek UL or other independent-laboratory approval, but standards vary greatly. And universal standards will be difficult to set: Some liners help prevent chimney fires better than others, but these others may be better able to withstand a fire.

When installed properly, maintained carefully, and used with proper fuel-burning techniques, all code-approved liners are safe. Follow instructions precisely, avoid creosote buildup—and you should have years of safe solid-fuel heating. PS

Avoiding creosote buildup

Begin each day with a hot fire; this burns off any creosote that has accumulated overnight.

Burn wood, don't smoke it. Keep logs from smoldering by adding oxygen and wood frequently.

Look inside the clean-out door at least every other week and clean whenever necessary.

These measures may use a bit more wood, but you'll live a safer and more relaxed life.—*M. B.*

SOURCES OF CHIMNEY LINERS

American Boa (Ventinox), Box 1743, Albany NY 12201; **D'Arcy Chimney Relining** (Readi-Flu), Box 387, Windsor CT 06095; **Dura-Vent** (Renew-A-Flue), Box 2249, Redwood City CA 94064; **Energy House** (Permaflu and Z-Flex), Box 4035, Manchester NH 03108; **Heat-Fab** (Saf-T-Liner), 38 Haywood St., Greenfield MA 01301; **Mazzeo's Sweep Suppliers** (Acu-Set), RFD 1, Box 1245, Rockland ME 04841; **National Supaflu Systems**, Box 289, Central Bridge NY 12035; **Norwegian Wood Stoves** (Iso-Kaern), Box 219, Clarkson P.O., Mississauga, Ont.; **Sleepy Hollow Chimney Sweeps & Supply** (Super-Flex), 22 Fire Island Ave., Babylon NY 11702.

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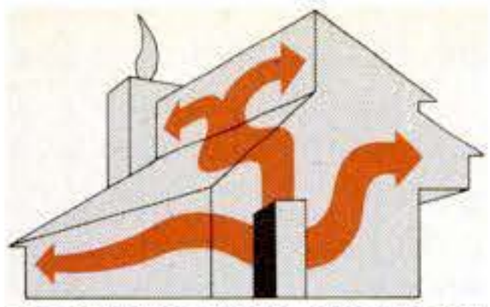


HOME HEATING SECTION

How to get every last Btu (safely) from your new catalytic wood burner

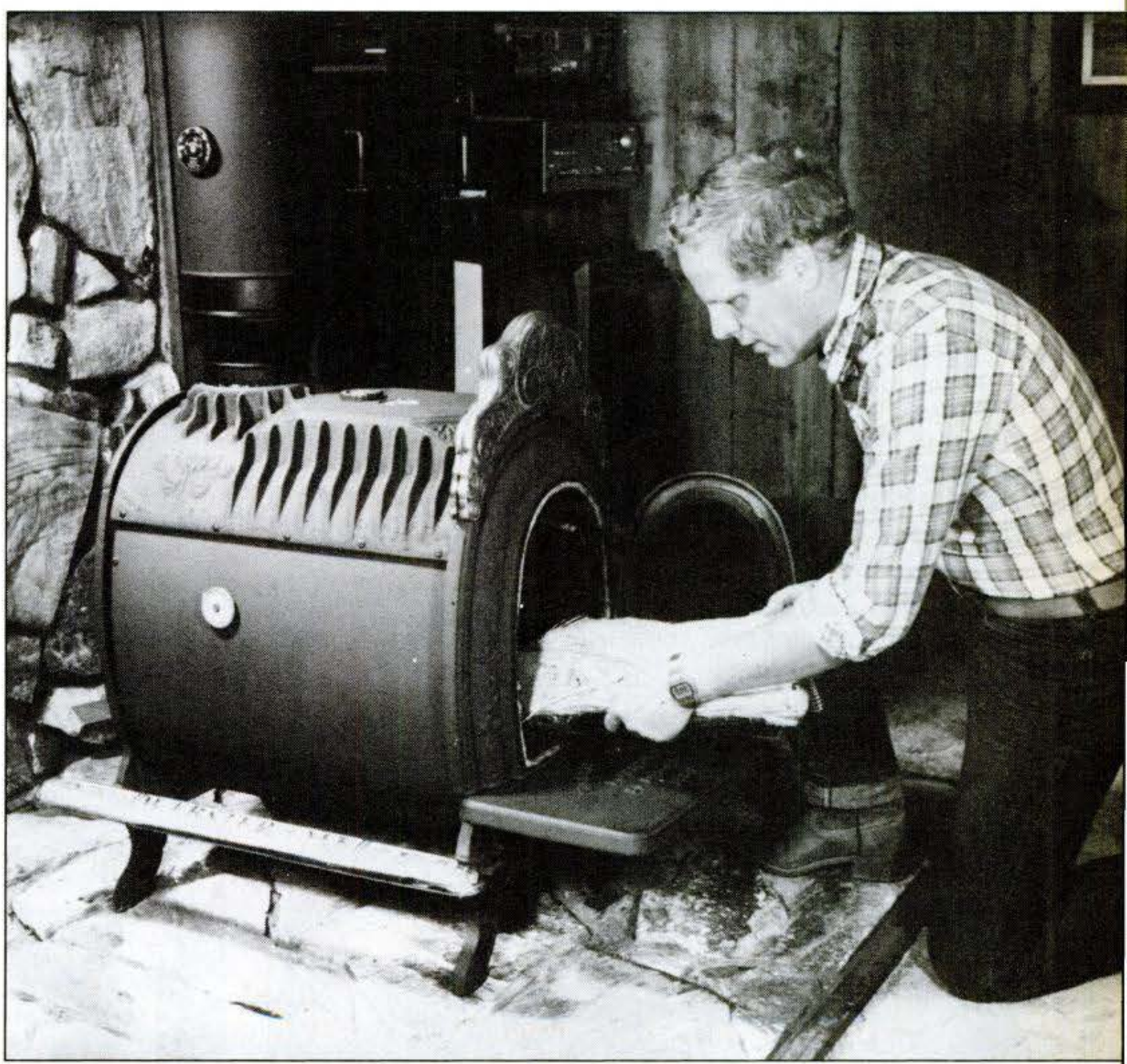
Proper use isn't difficult, but it *is* slightly different

By EVAN POWELL

Once upon a time in the land of America, the fuel that the people used to heat their homes became scarce and very expensive. In many areas they turned to stoves that burned the wood from the forests around them. But soon they learned that the stoves caused a tarry accumulation that could start dangerous fires in their chimneys. So the craftsmen drilled some holes in the stoves to change their air flow. "No more creosote," the craftsmen cried, and the people bought more stoves.

But chimney fires continued, and it also became apparent that the wood stoves were not very efficient and used more wood than they should. The craftsmen made more alterations. "No creosote and high efficiency," they cried, and again the people came and bought the stoves. But chimney fires and low efficiency persisted, and there came another dire warning: The stoves were breathing poisonous gases into the air.

As the craftsmen were wringing their hands, a white knight rode up with a magic amulet for the stoves. "Build your wood stove around this and you'll protect yourself from the evils of creosote and poisonous fumes—and get far better efficiency to boot," he told the craftsmen. So a number of them took the amulet, built their wood stoves around it, and then cried, "No more creosote, no more toxic fumes, and the highest efficiency yet." But by now the people had wearied of the craftsmen's cries and few of them came to buy the wood stoves with the magic amulet.



Regular but light feeding keeps catalyst at active temperature. Deeply finned combustor housing gives superb heat transfer in ornate, antique-style Webster Oak stove.

With apologies to Aesop, this modern version of "The Boy Who Cried Wolf" is no fable. The amulet is the catalytic combustor.

Last January we told you about our initial experience with wood-stove catalytic combustors, noble-metal-coated honeycomb discs that promote fuller burning of hydrocarbons in wood. Since that time I've worked with seven more catalytic stoves, including several new models with improved features, and I'm more enthusiastic than ever about them. But life with a catalytic wood stove is quite different from what you may be used to. Before you buy one, you should be aware of their special use procedures and limitations.

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First you must understand how and why the catalytics work. Wood contains a great many different chemical compounds, some of which burn only at temperatures higher than those commonly reached in wood stoves. As much as 30 percent of the energy content of wood burned in stoves may be exhausted as unburned particles in smoke. Besides wasting energy, incomplete burning leads to creosote buildup and pollution problems.

Catalytic combustors are designed to cause the burning of complex molecules to take place at about half the temperature normally required. Actual performance depends on the design of the stove and combustor.

The catalytic cell itself is a round or square ceramic grid several inches thick that is coated with platinum, palladium, rhodium, or a combination of these. To be effective, it must be located directly above the stove's firebox so it "sees" the smoke when it is hottest. A bypass damper, operated either manually or automatically when the stove's door is shut, diverts smoke past the combustor until its firing temperature (500 degrees F) is reached.

Since the catalyst doesn't operate until it reaches this temperature, you need a hot kindling fire to get it going from a cold start. You must make sure the damper is open at this time to protect the combustor from direct flame exposure. During this period the stove operates like any wood stove, but there is an excess of combustion air, a condition that tends to yield little creosote. When you have a sustained hot fire going, you close the damper and the combustor becomes active.

Knowing when to close the damper can be a matter of intuition, or you can add some auxiliary temperature gauges. But don't be tempted by the viewing port (a heat-resistant-glass window on most stoves that allows you to watch the combustor in operation) for a visual cue. The cell burns with a bright red glow, but only during the upper limits (above 1,000 deg. F) of catalytic activity. It may also be active when it's not glowing.

A better way to judge activity is to install a thermometer (a magnetic type will do) near the viewing-port window. The temperature will rise markedly and rapidly when the combustor ignites. It's also a good idea to mount a thermostatic probe in your stovepipe to measure the temperature of flue gases. Flue temperature drops in a well-designed stove after combustor ignition because much of the heat is being transferred to the room.

Once the combustor is lighted, one of the advantages of catalytic stoves will soon become evident. You get astonishingly long burn times, so you don't have to feed the stove as much. Catalytics use about one-third less wood, on average, than conventional stoves for the same heat output. I've gotten better results by loading them with the same frequency but using

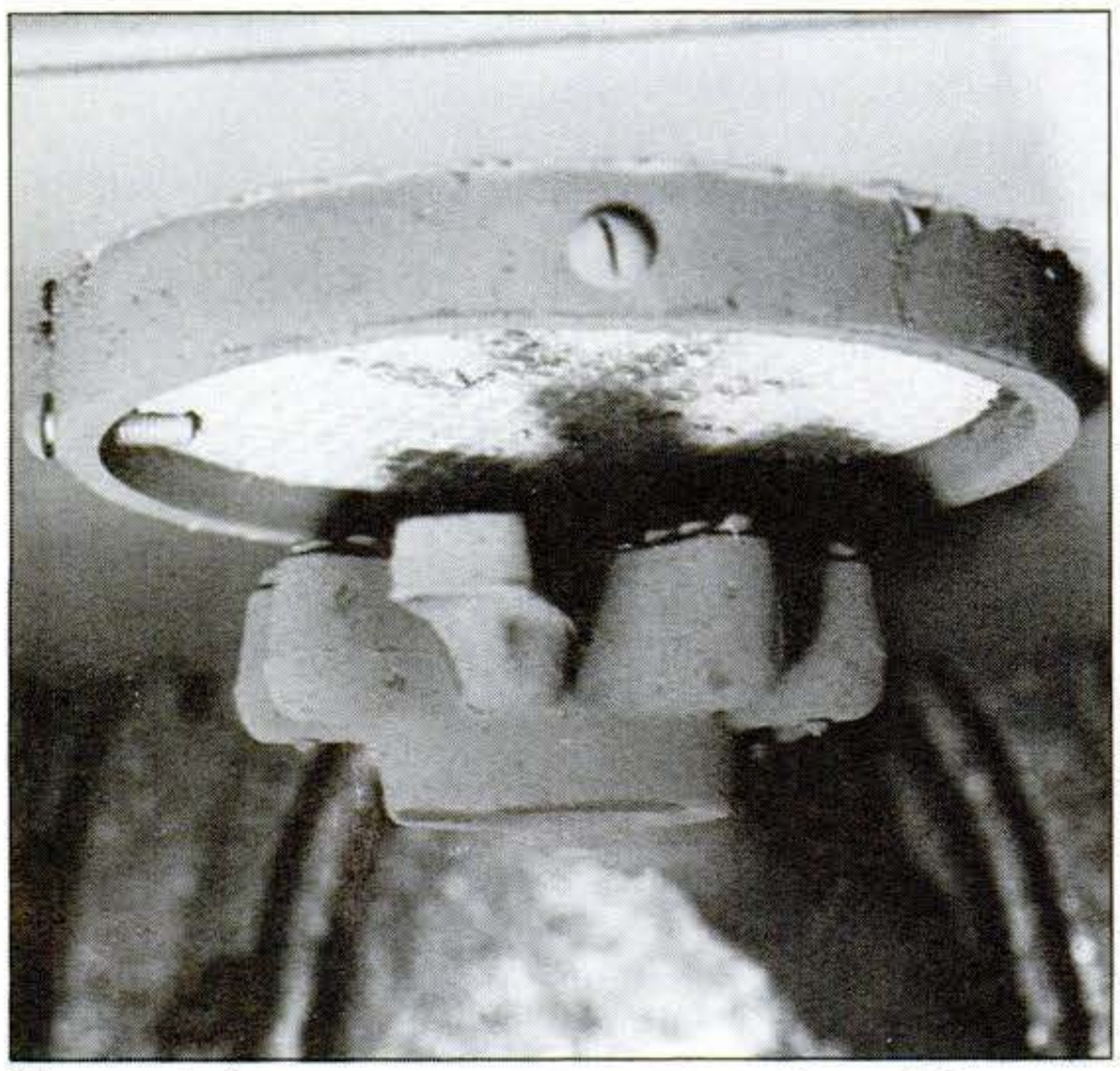
Second-generation catalytic wood burners

Since our first report, a great many new catalytic wood burners have reached the market. The differences I've found are not spectacular but are significant.

Several of the new stoves show a lot of attention to baffling procedures to get the most from the additional generated heat. After all, the excess heat available from the combustor would simply be wasted if it were allowed to flow up the chimney. In our Webster test unit (opening photo), the ornate design hides an elaborate, deeply finned heat sink weighing nearly 100 lbs. Timberland uses a U-channel heat exchanger and a "dropped" combustor to obtain good heat-transfer characteristics.

Some of the new units contain a precision thermostatic control to produce desired heat output while maintaining combustor operation. The device is made by Condar, and I tried one of the laboratory models the company developed for testing and demonstration. What this lab "mule" lacked in appearance it more than made up for in performance: It recorded burning times of 27 to 28 hours and exhibited excellent heat transfer. I also tried out a test version of the pedestal-mount Royale Scot adapted for the Condar control. While the heat-transfer characteristics of this stove weren't as good as the Condar lab model (the designer was still experimenting with the baffling when I received the test model), it proved to me that the thermostatic control is an effective solution to the control problems that plagued some of the early catalytic stoves.

Other new products extend the catalytic principle beyond wood stoves. Hart has introduced the first catalytic fireplace insert with combustion efficiency of up to 95 percent. And Steel King's new wood-fired boiler and warm-air furnace have fireboxes that are specially designed for catalytic combustion.



Most catalytic stoves use a screen over combustor inlet to protect it from damage and initiate gas turbulence. Webster's ported inlet guard looks like a gas burner in some firing phases.

Glass doors of Lavec 2000 don't smoke up as much as on other stoves, but are potential source of leaks. Catalytics don't produce much flame, but gas-flow patterns are interesting to watch.

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less wood, rather than the other way around. That avoids "dumping" the combustor by letting it cool down too much. Remember, you don't want the actual temperature to drop below about 500 degrees. If it does, the combustor will go out and you'll have to refire for a few minutes.

As with any wood stove, dry, seasoned wood works best. The higher moisture content of green wood can lower the flame temperature and consume heat that could be used for heating your home. Unlike conventional stoves, catalytics are designed to burn natural wood only. Don't use them as incinerators: Such things as papers with printed inks, plywood scraps, painted or stained wood, and compressed logs with binders contain chemicals that can damage the thin metallic coating on the combustor cell. And if your stove is designed to burn coal as well as wood, you must remove the catalyst before burning coal.

After the fire is rolling along, you can adjust the air-intake dampers to maintain the best level of catalytic activity for your particular needs. You will find, though, that even with the dampers throttled down to lowest firing levels, the stove will put out a great deal of heat. So it's best not to use a catalytic stove on mild days (or a conventional stove, either, since air-starved operation increases creosote buildup).

Once you live with a catalytic for a short time, you'll find that proper operation is a snap; proper maintenance is even easier. Yet, judging by the mail I've received since our first article, many people believe that plugging of the combustor is a serious problem.

Only once have I been able to plug a combustor, and that was using a non-standard, high-resistance cell—and using it entirely improperly (starting a fire with green, pitchy wood and closing the damper long before the cell reached proper temperature). Even then, only a small amount of smoke escaped into the room before the fire quenched itself.

If you follow recommended procedures it is doubtful that you would ever plug a catalytic combustor. Nevertheless, regular inspection and maintenance should not be ignored. Most stove makers have designed the catalytic units so they drop clear when stainless-steel pins are removed. Others are mounted in an insulated "can" that can be lifted out. When inspecting, check the entire wood-burning system, including safety bypasses in the stove and chimney. Even when performing properly, catalytic stoves let some creosote accumulate. PS

Smoke-scrubber wood stoves

—cleaner non-catalytic burners

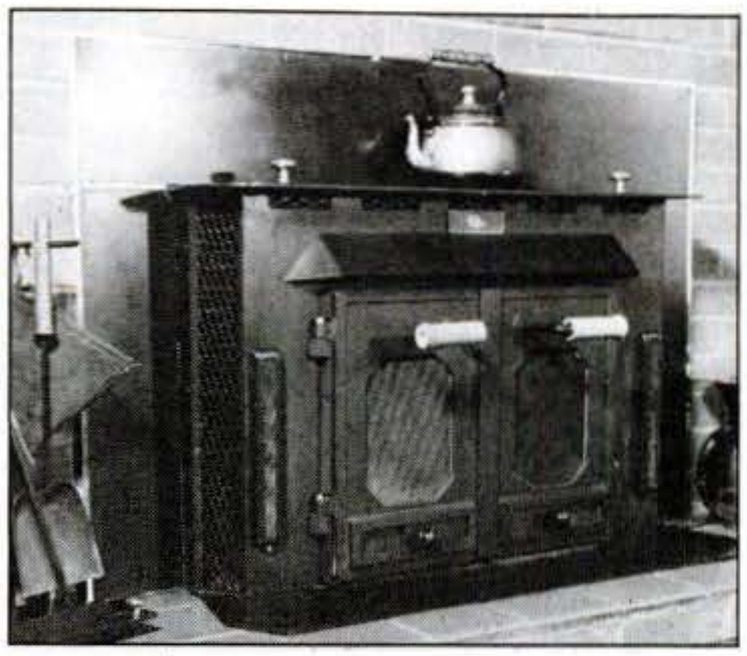
Until the early '70's, wood heating in most modern homes was purely aesthetic. Then, like a technological Rip van Winkle awakening from an 80-year sleep, it was suddenly thrust back into a major role as American homeowners pursued an evasive dream of self-sufficiency.

Unfortunately, wood-stove design had been hibernating along with the hardware. The best that the newly reborn industry could offer was the air-starvation principle originally developed to solve the problems of short burn times and great fluctuations in heat output. This in turn created a new set of problems—greatly accelerated creosote buildup in chimneys and massive emissions of carbon monoxide and hydrocarbons in the low-burn mode. Until the catalytic combustor was introduced recently [PS, Jan. '82], little was done successfully to remedy these problems.

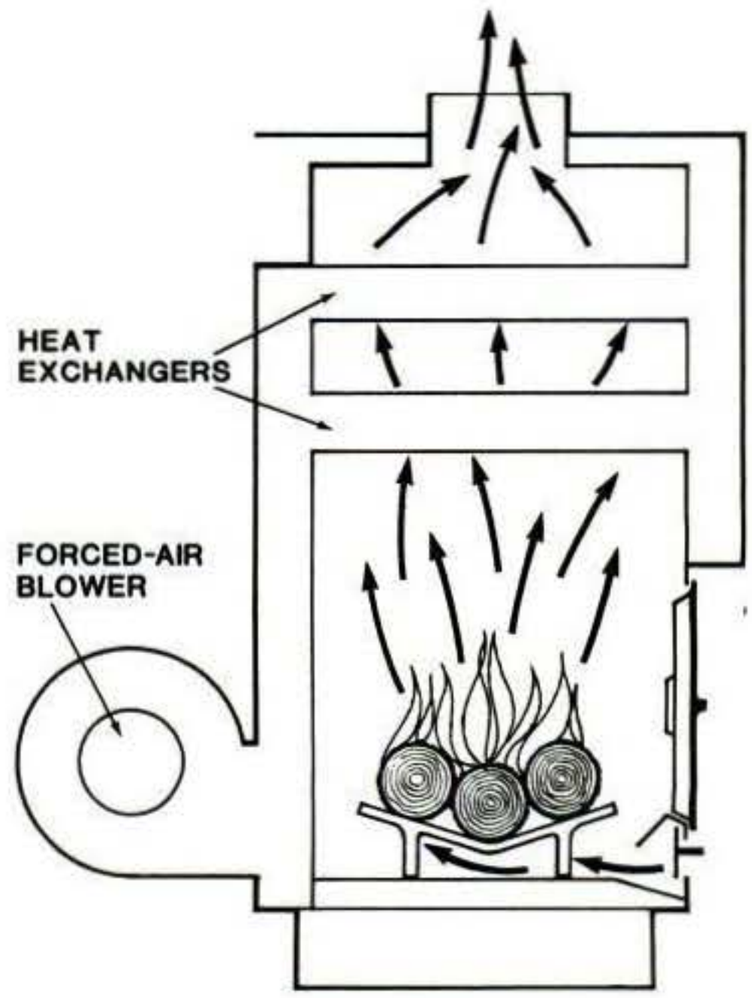
But not all stove manufacturers are going the catalytic route; some are attacking the same problems in different ways. The Juca Super-Fireplace is a large non-airtight unit with huge heat-exchange surfaces. Combustion chamber and heat exchangers are computer-designed for maximum heat transfer; even the slope of the stove walls corresponds to the contracting volume of the hot gases as they move through the passageways. The forced-air blowers used with the system are of high capacity by wood-heating standards, ranging from 465 to 2,500 cubic feet per minute. The size of the unit allows it to burn large unsplit logs, giving a relatively stable, low-intensity fire over a long period of time. According to designer Carl Johnson, they've never encountered a true creosote problem in any Juca installation. Juca (1400 Lake St., La Porte, Ind. 46350) offers units in free-standing, central-furnace, and fireplace versions in three colors, plus black.

Buck Stove's new baffled design has no direct vent opening at top or rear as do most typical wood-burning stoves. Instead, smoke is forced to travel back through the fire and up behind baffled walls to reach the outlet, a process that the manufacturer claims reburns the smoke. The chimney to which this test unit was connected last season showed no residue other than white fly ash, according to the manufacturer, Buck Stove, Inc. (Box 8789, Asheville, N.C. 28814). The system is incorporated in several models of triple-wall stoves and fireplace inserts along with an electronic thermostat with infinitely variable fan speeds matched to the heat output available.

Wood-heating technology may have been sleeping until recently, but new stove designs reveal an industry wide awake.—*Evan Powell*



Buck Stove's Smoke Scrubber (above) has no vent openings in top or rear as do most wood stoves; rather, smoke must travel back through the fire, where it is reburned, says the manufacturer. The computer-designed Juca fireplace (right) is a non-airtight stove with huge heat-exchange surfaces.



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AUTO MAINTENANCE

Automotive trouble-shooting quiz

By STEVE MERCALDO
DRAWINGS BY EUGENE THOMPSON

Questions

1. Excessive engine-oil consumption

Lately, the car you use only to drive to and from the railroad station has been consuming oil at an unbelievable rate: You must add a quart of oil to the V8 engine every 200 miles. To make matters worse, blue smoke belches from the tailpipe during all modes of engine operation. Tired of being the local air polluter, you decide to trouble-shoot the problem.

You begin by searching for oil leaks. With the vehicle safely supported on jack stands, you crawl under the car and inspect the underside of the engine. There are some spots that are damp with oil, but no bad leaks are evident.

It's been a long time since you last serviced the engine, so you proceed to change the oil and filter. Instead of using the recommended-viscosity oil, you add a heavier-weight oil. Thinking that perhaps you've solved the problem, you lower the vehicle and road-test it. There is no improvement. Disappointed, you return to the garage to continue searching for the problem.

Performing a compression test is the next logical step, but first you remove and inspect the spark plugs. You notice that the spark plug from the rear of each bank of cylinders is oil-fouled. Expecting to find low compression in these cylinders you proceed with the compression test. To your disbelief, compression in all cylinders checks within manufacturer's specification. Still not convinced, you take a wet compression test by squirting about a teaspoonful of oil into each spark-plug hole and retaking compression. Each cylinder shows a slight increase.

Now you're really baffled. Perhaps a hotter-range spark plug will do the trick. You gap an appropriate set of plugs and install them in the engine. When the engine is restarted, it runs smoothly. But after several minutes of running, blue smoke is still coming from the tailpipe.

Next, you attach a vacuum gauge to a source of manifold vacuum; it reads a steady 19 inches.

Maybe the positive crankcase ventilation PCV system is malfunctioning. With the engine idling, you remove the PCV valve from the engine and plug it with your finger. Engine rpm drops about 50. Then you reinstall the PCV valve, remove the oil-filler cap, and place a piece of cardboard over the oil-filler hole as the engine continues to idle. The piece of cardboard stays in place over the hole; the PCV system is okay.

Could the valve seals be bad? A check of some old repair bills indicates that new seals were installed just 8,000 miles ago.

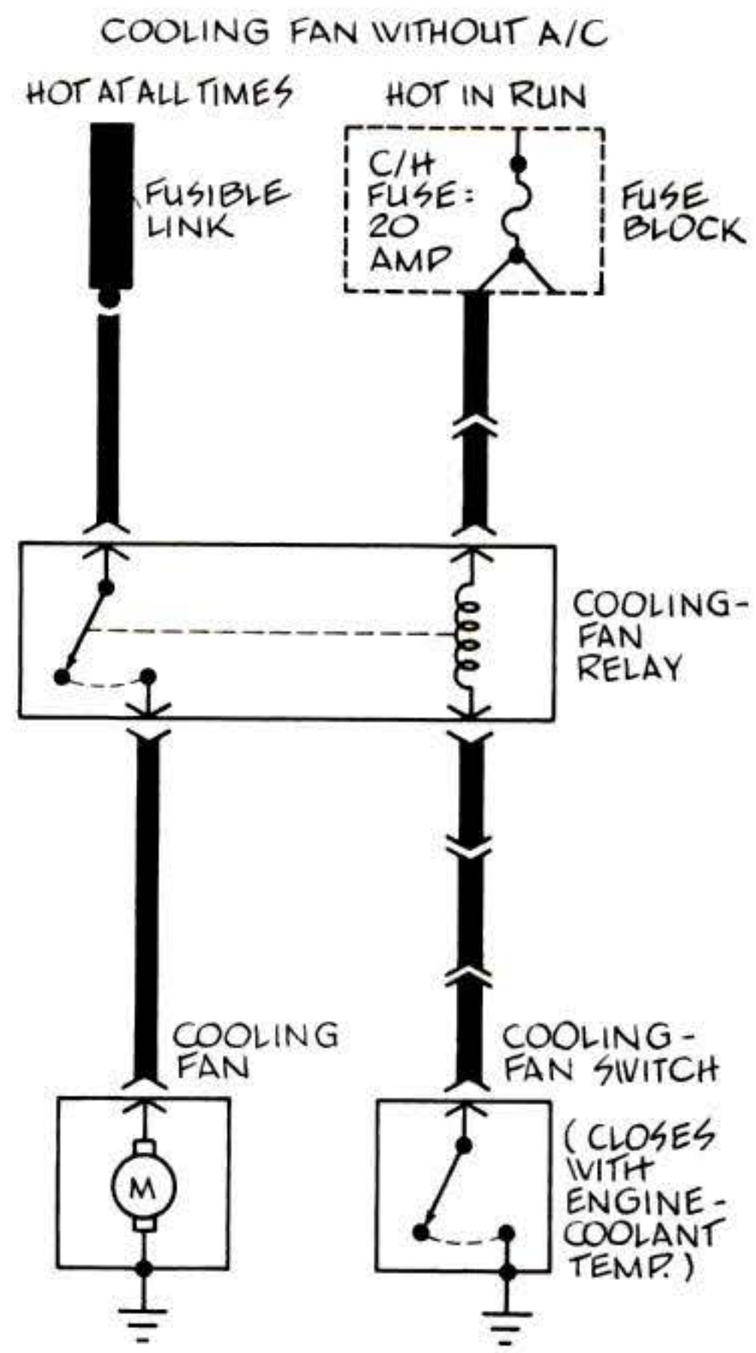
What's causing the excessive oil consumption?

2. Inoperative electric cooling fan

Pinpointing the reason for an overheating engine can sometimes be tricky. What appears to be a simple problem can force even the best mechanic to crack open a repair manual.

Such is the case with your car's overheating engine. It's obvious that the cause of the problem is an inoperative electric cooling fan on your transverse engine's cooling system, but you need to find the faulty part, and that task is more difficult.

The electric cooling fan uses the circuitry shown in the accompanying



drawing. In an effort to find the problem, you begin by checking the fuse. With the ignition switch turned to the "on" position, a 12-volt test lamp

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lights when touched to either end of the fuse. It's okay.

Next you disconnect the fan-motor wire from the cooling-fan relay and connect a No. 14-gauge wire between it and the battery's positive terminal. As soon as the connection is complete, the fan motor begins to run. You check the fusible link, and it looks good: When you touch a test lamp to its connection on the cooling-fan relay, the lamp lights.

Perhaps current isn't being supplied to the cooling-fan relay by the ignition switch. To check it, you turn the key to the "on" position and touch a 12-volt test lamp to where the switch is connected to the relay. The test lamp lights.

Finally, with all the other wires connected properly in the circuit and the ignition switched on, you disconnect the cooling-fan-switch wire from the cooling-fan switch and touch it to a good ground. The fan motor operates when the connection is made.

Why doesn't the cooling-fan motor operate correctly?

3. Difficulty in shifting gears

Your reputation as a weekend mechanic is put to the test. At a recent social event, a neighbor asks for advice concerning a problem with his pickup truck. Each time he attempts to shift into reverse gear, he says, the gears grind. He also has difficulty when shifting into forward gears. Challenged by what appears to be a minor problem, you suggest that he drive the truck to your house the following weekend.

You begin trouble-shooting by taking the truck for a road test. It doesn't take long to verify the complaint. The transmission indeed grinds when shifted into reverse, and it takes real muscle to shift into the four forward gears.

Back at the garage you jack and support the truck and check the transmission-fluid level. With the filler plug removed, you find the level is correct: Lubricant is up to the lower edge of the filler-plug hole.

Next you adjust clutch-pedal free play following the procedure described in the shop repair manual. Feeling confident that adjusting the clutch linkage has solved the problem, you lower the vehicle and take it for a ride. The problem persists.

Maybe the noise is the result of shifting too fast. Just to be sure, you push the clutch pedal all the way to the floorboard, wait five seconds, then shift into reverse. There's no difference; it still grinds.

Could it be a clutch-linkage problem? You begin checking the linkage under the dash. The pedal-support bushings and rod bushings check out, and there's no excessive free play. To check the linkage under the body, you jack and support the vehicle. The linkage looks good: There are no signs of bent, broken, or loose parts.

You inspect the linkage in motion as a helper slowly pushes the clutch pedal to the floor and then slowly releases it. Again you see no signs of excessive free play; the linkage responds immediately to clutch-pedal movement.

What could be causing the shifting difficulty?

4. Brakes require frequent adjustment

Ever since you did a complete brake job, your self-adjusting brake system has been plagued by a problem: The brake pedal gets low after several weeks of driving. Manually readjusting the rear drum restores the pedal to normal height, but the pedal begins to lower with each day of driving. You bleed the hydraulic system, but no air escapes as the bleeder screws are opened. So you begin to search elsewhere.

Since adjusting the rear brakes seems to solve the problem at least temporarily, you direct your attention to them. With the car safely supported on stands, you remove the rear wheels and drums. A visual inspection of each brake doesn't reveal anything unusual. Brake shoes are worn slightly but do not show signs of overheating, cracks, uneven wear patterns, loose brake lining, or the presence of brake-fluid contamination.

Brake hardware checks out: All springs and retainers are in place; the self-adjusting mechanisms are installed correctly and move freely; both star-wheel adjusters can be turned easily by hand; and there are no missing teeth on either adjuster.

You inspect the wheel cylinders for leaks by pulling the dust boots back. Both cylinders are dry.

Finally, you check each drum for size with a drum micrometer. Both measure within the allowable specification. The drum contact surfaces are free of cracks, hot spots, and abnormal wear patterns.

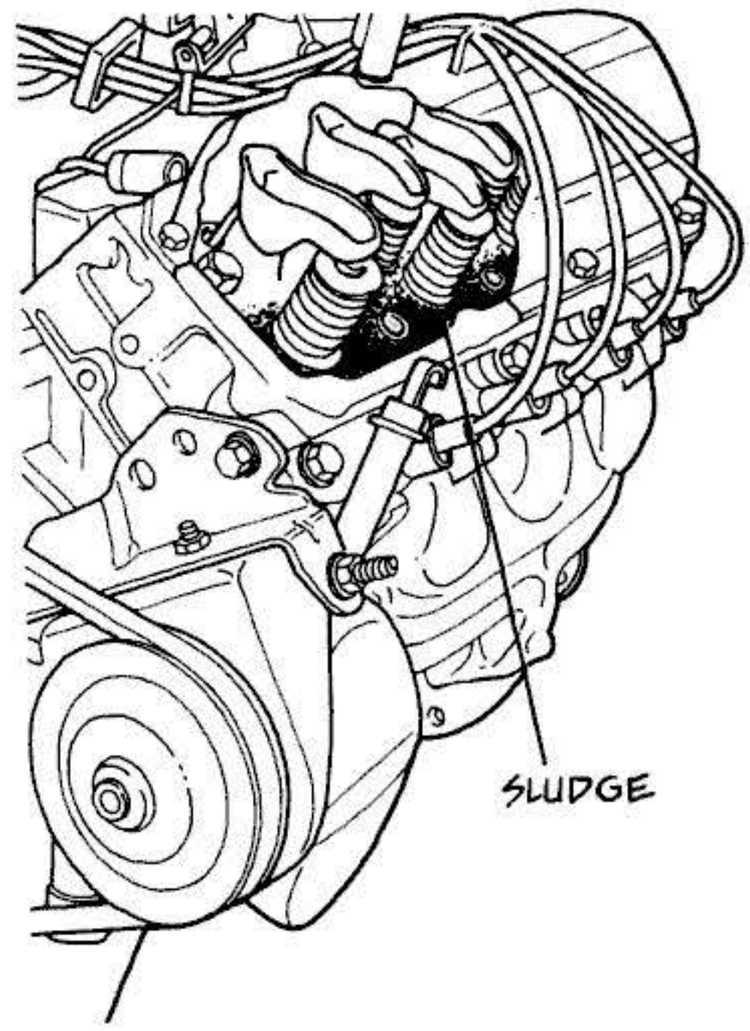
Since you find no obvious problem with the rear braking system, you figure the dual master cylinder is malfunctioning and decide to install a new one. Several weeks later you're back to adjusting the brakes.

Why do these brakes require frequent readjustment of the rear brake shoes?

Answers

1. The oil-return holes in the engine's cylinder heads are stopped up with sludge.

Normally, oil is delivered under pressure to the rocker arms and push rods through passages either in the push rods themselves or the rocker-arm shafts. After the oil has lubricated the rocker arms and push rods, it returns to the oil pan via holes in the



cylinder head.

In this problem, oil could not drain back to the oil pan and so flooded the area under the valve covers. As the engine operated, oil was drawn into the combustion chamber through the valve guides.

Failing to change oil and filter at regular intervals can cause engine-sludge buildup; operating an engine below normal engine temperature can also cause it. An engine will run cool if it has a faulty cooling-system thermo-

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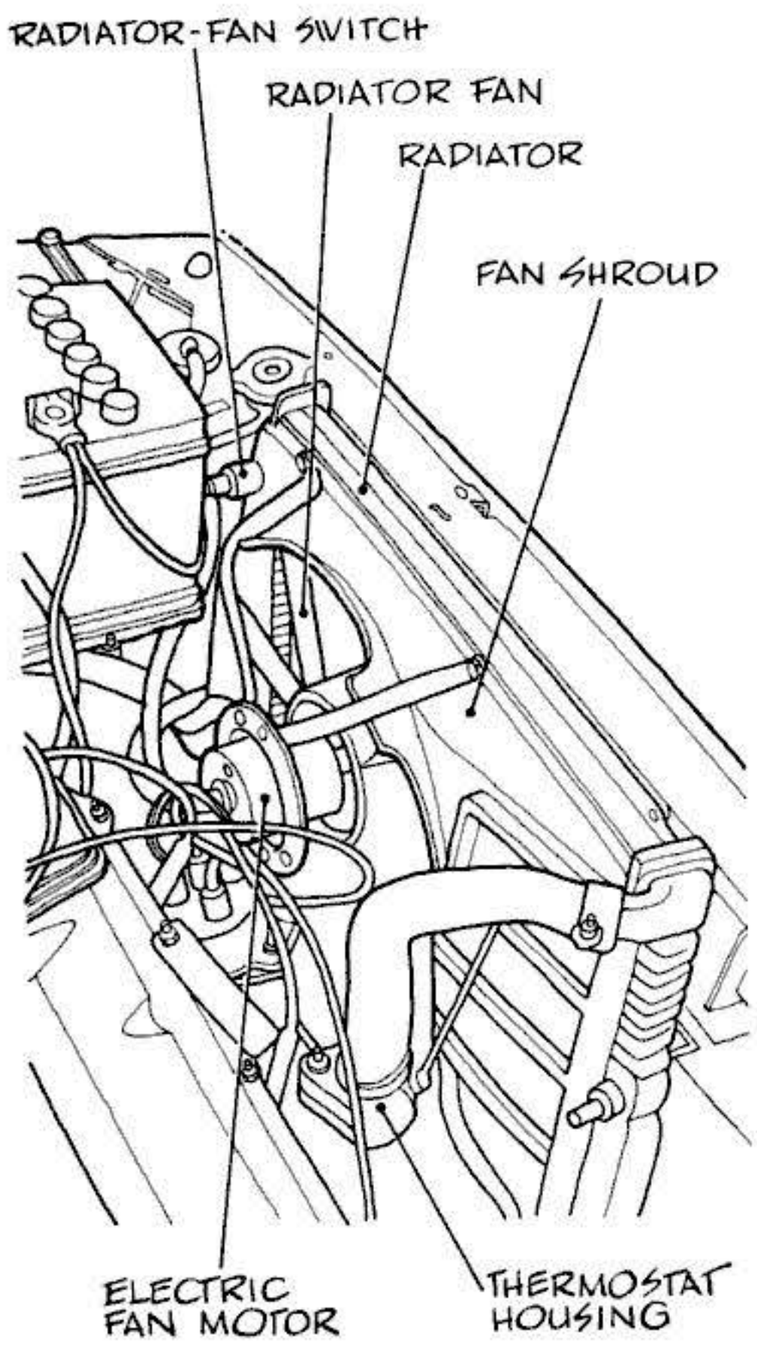
stat (the thermostat is stuck open, for example) or if it's used only to travel short distances.

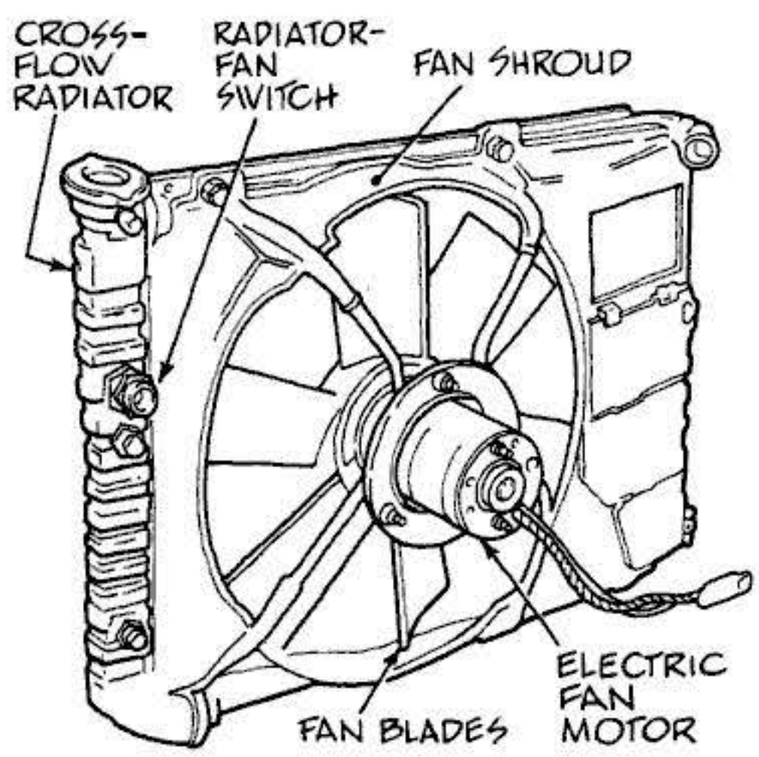
Here, the latter case was true. Because the car was only used to go to and from the railway station, it rarely got to run at the correct temperature. Changing oil and filter more frequently on such vehicles will help prevent sludge buildup.

2. The cooling-fan switch is bad.

Checking the regular fuse and fusible link was the right approach: If



either were blown, the electric fan would not operate. Connecting the fan motor directly to the battery is a quick way to verify its operation. The key to finding the problem was connecting

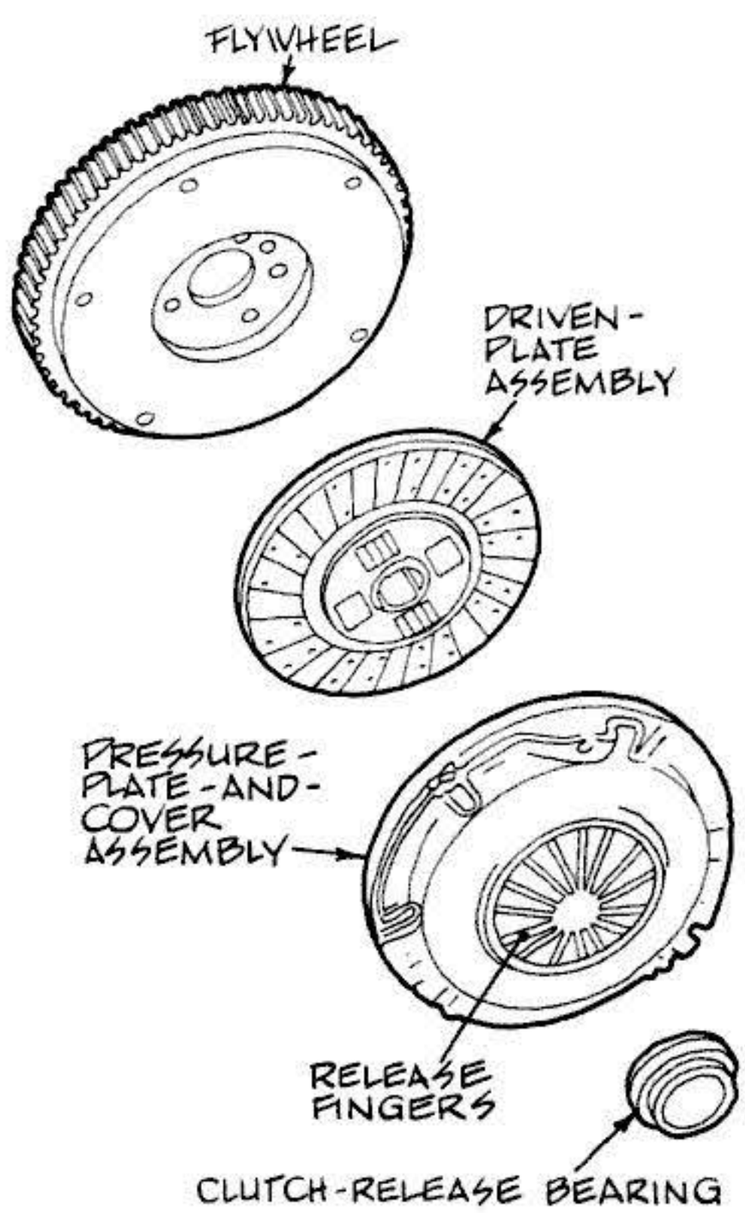


the cooling-fan-switch wire directly to ground. When the fan motor operated, this step eliminated every part in the circuit and pinpointed the fan switch as the faulty part.

Here's how this particular circuit operates: The fusible link delivers voltage to the cooling-fan relay at all times, even when the ignition key is turned off. Whenever the ignition is turned on, voltage is also delivered from the ignition switch to the relay. On this engine, if the coolant in the radiator reaches 93 degrees C (200 F), the cooling-fan switch (which is screwed into the radiator tank) closes and current flows from the ignition-switch wire on the relay through the relay to ground at the cooling-fan switch. This action closes the relay contacts, and current flows from the fusible link to the fan motor. As the coolant temperature lowers, the cooling-fan switch opens and the relay does not send current to the fan motor.

3. The pressure-plate assembly is defective: Several diaphragm spring release fingers are broken.

Normally, whenever the clutch pedal is pushed down, the clutch linkage moves the clutch-release bearing against the release fingers, disengag-



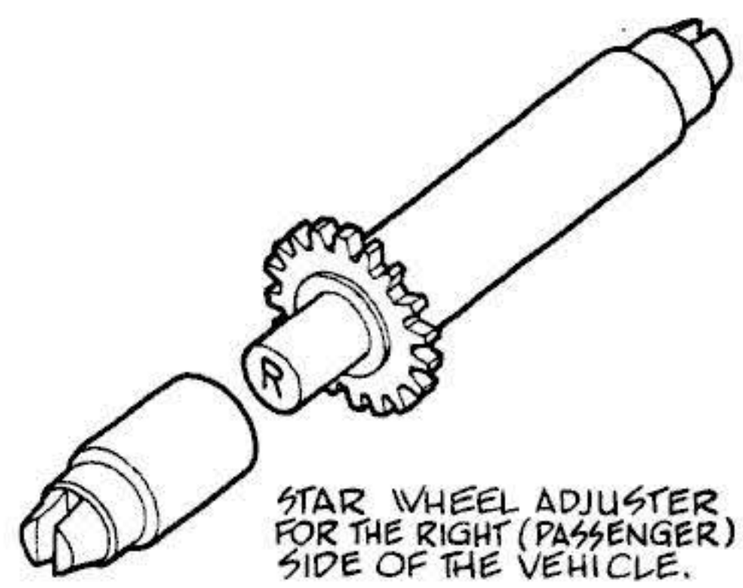
ing the clutch disc (or driven plate). When the clutch is completely disengaged, the disc stops turning because it is no longer squeezed between the spinning flywheel and the pressure plate. Since the transmission input shaft is splined to the disc, it also stops turning, and gears can be shifted without noise or difficulty.

But when release fingers break, the clutch disc doesn't completely disengage and the transmission input shaft continues to turn. Result: Gears clash and are difficult to shift.

Since the external linkage checked out okay and clutch free play was adjusted correctly, the next step would have been to remove the transmission and inspect the clutch assembly. You would have then discovered the broken release fingers.

4. The star-wheel adjusters are installed incorrectly.

There is a left- and a right-side adjuster. The left adjuster must be



installed on the left, or driver's, side of the vehicle and the right adjuster on the passenger's side. Each adjuster is marked under the adjuster cap with an L or R.

When does a typical drum-brake self-adjuster operate? An adjustment will only take place when certain conditions exist. First, the vehicle must be moving backward. Second, the brake pedal must be applied. Third, there must be sufficient clearance between the drum and brake-shoe lining to allow the adjuster lever to make contact with the next tooth on the star-wheel adjuster. The star wheel now turns, lengthens, and brings the shoes closer to the drum, eliminating the excess clearance. Under normal conditions, self-adjusting mechanisms will compensate for brake-shoe-lining wear and maintain acceptable brake-pedal height.

When the brake job was done, the adjusters were mixed up and installed on the wrong wheels. After that, each time the lever in the self-adjusting mechanism moved the star wheel, drum-to-shoe clearance was increased instead of decreased. Increasing the clearance caused the brake pedal to get low.

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Fall Home Value Ideas

How to drill big holes in almost anything

By THOMAS H. JONES

Drilling holes up to 3/8 inch in diameter is usually simple enough—most of the time you can do it with twist drills. If you're working with masonry, you substitute a carbide masonry bit. But that's where the simplicity ends. Larger holes require more-specialized bits.

Twist drills that you can chuck in a home-shop tool are limited in size, and their cost rises as the diameter increases. When holes get bigger than 3/8 inch, it may pay to use a bit made for the particular application. The payoff is lower cost; easier, faster drilling; and cleaner holes.

You can drill clean, accurate holes in wood using twist drills (which are designed for drilling metal)—*if* the drill is sharp, *if* you start the hole with a countersink to guide the drill, and *if* you feed the drill slowly (so hard-soft variations in the grain structure won't lure the drill off at an angle). And you must be careful to clamp the work, because a twist drill has a strong tendency to pull itself into the wood with sometimes messy results.

There's no need to risk that trouble, however. For just about every large-bore drilling application (wood, metal, or plastic), there's a specialty bit that does the job better than a twist drill, and often for less cost. Here's how to use them:

Spade bits. Chuck these bits in a portable electric drill to chew holes fast in studs

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How to drill big holes

[*Continued*]

and joists. The holes are rough, but it matters little in studs. In a drill press, use them to make clean-through holes—or bottomed holes, if you can tolerate the deep penetration of the point. They're virtually uncontrollable in end grain, which makes them a poor choice for drilling dowel holes, no matter how well hidden.

Auger bits. Although auger bits are usually seen with square, tapered tangs for use in a bit brace, they are also made with round shanks for chucking in a power drill. Auger bits are sized in 16ths of an inch: a No. 8 bit is 8/16, or 1/2, inch in diameter. The feed screw of an auger bit accurately locates the hole and helps pull the spurs into the work, but once the point breaks through, it's usually muscle power that completes the hole. Using a straight-shank auger bit on a drill press or electric hand drill requires care because the feed screw can abruptly pull the bit out of control and into the work. To lessen the problem, partially file away the threads on the tapered feed screw.

Auger bits are made in several patterns. The solid-center bit is forged from bar stock. It's the strongest and least expensive. The Russell Jennings type is twisted from strip steel; it produces cleaner, more-accurate holes and has better chip removal. Use long ship auger bits for boring deep, clean holes.

Power-bore bits. These bits drill clean, accurate holes in wood. They are roughly equivalent in performance to brad-point drills (below), except for the longer tip, which in many applications can be as objectionable as that on a spade bit.

Brad-point drills. The small tip (only 3/16 inch long) on this bit starts the hole accurately and keeps it going straight. The two spurs slice through the wood, keeping the sides of the hole clean as the flutes shave

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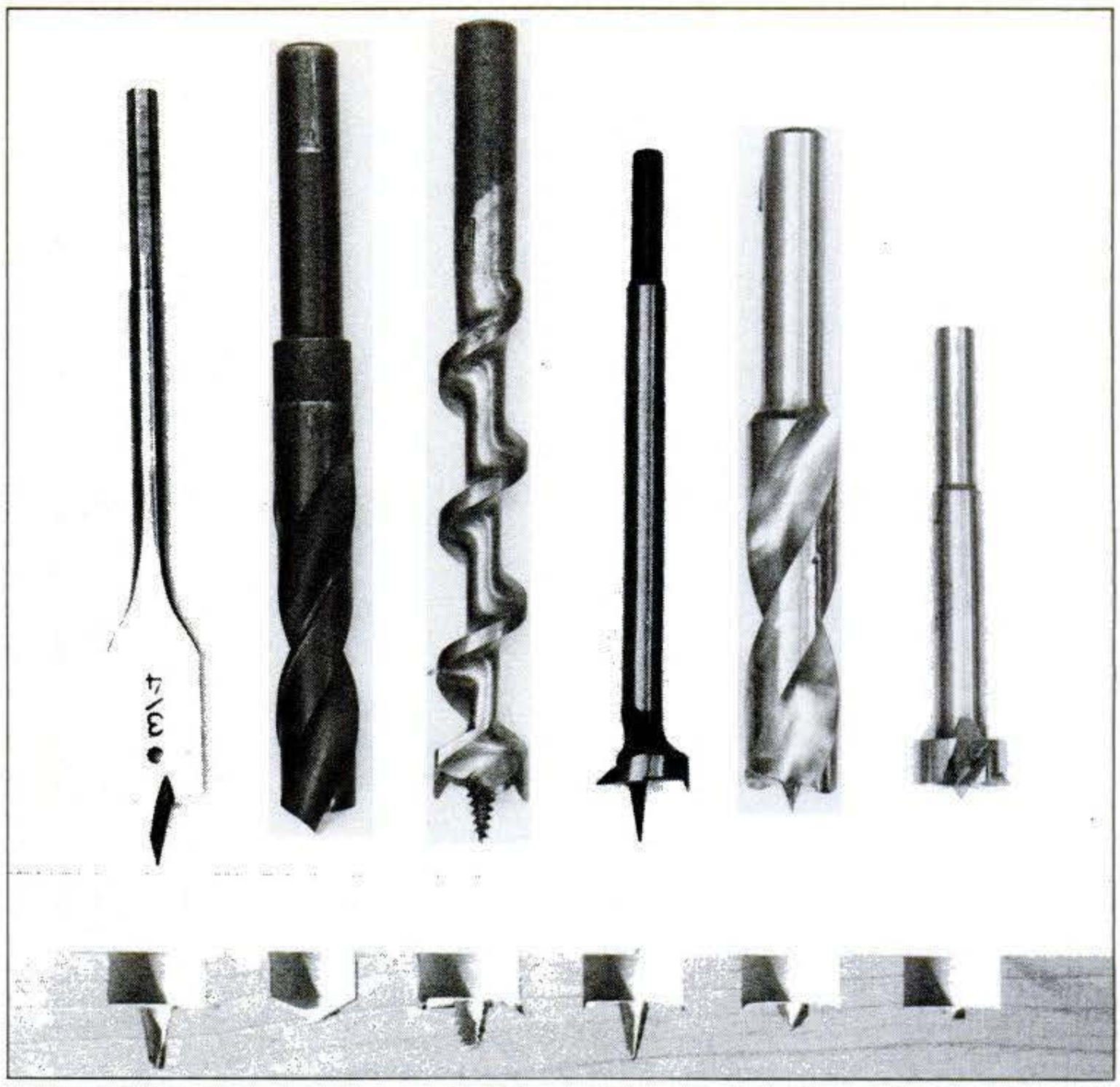
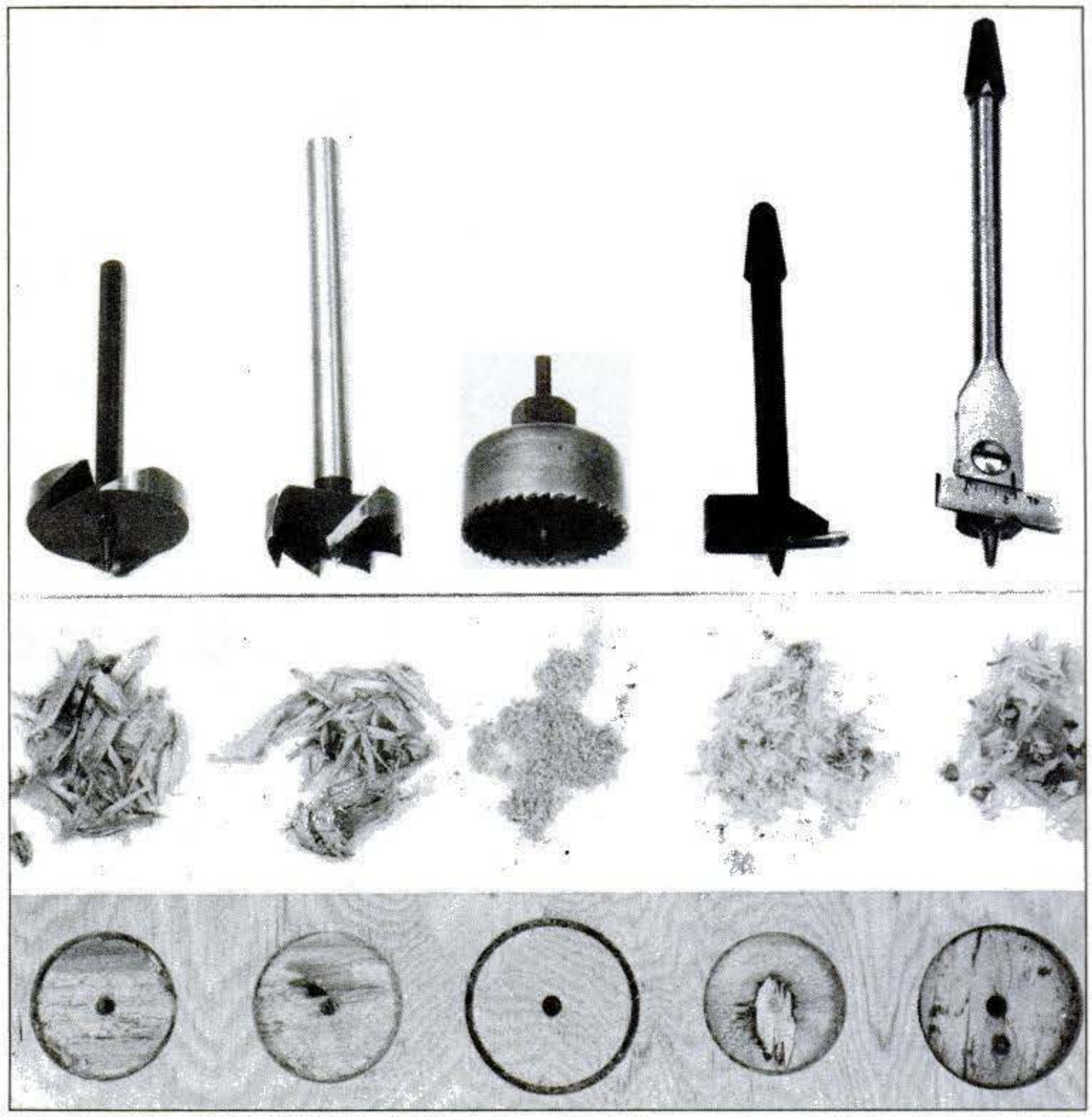
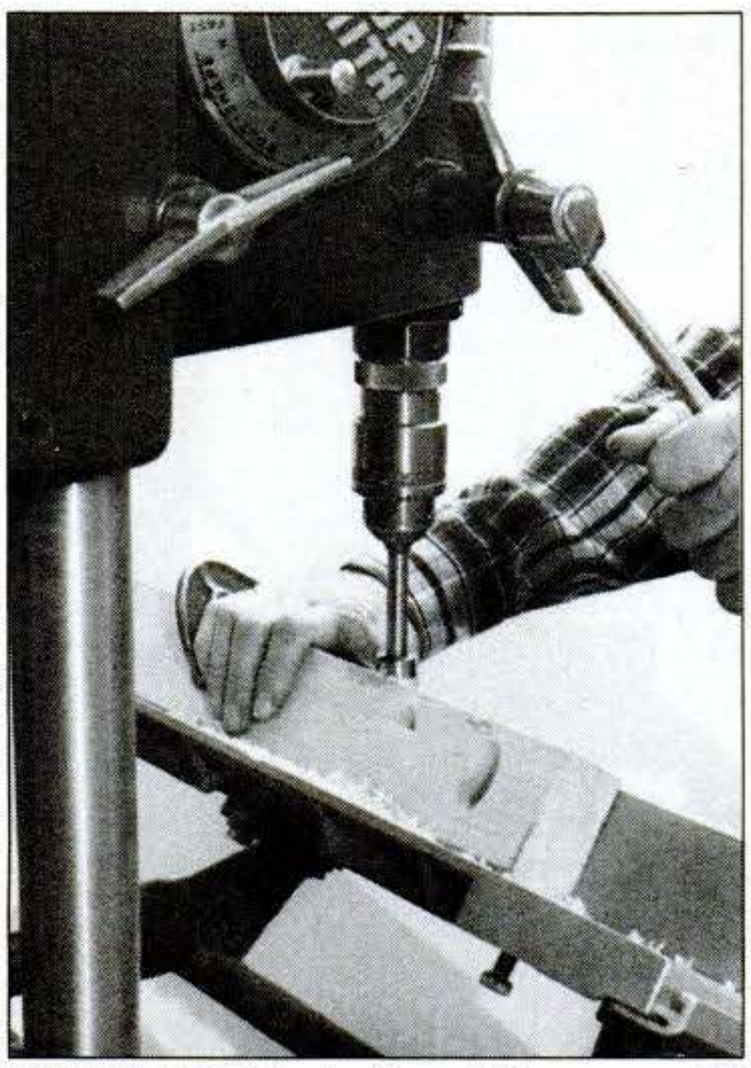


HOLE PROFILES above are made by various bits (from left): spade bit, high-speed-steel twist bit, solid-center auger bit, Stanley Power Bore bit, brad-point bit, and Forstner bit.



LARGE-DIAMETER WOOD BITS, with the holes they make and the cutting debris they produce, are (from left) Stanley lock-set bit, multi-spur bit, hole saw and mandrel, door-lock bit, expansive bit. Holes are cut in fir plywood. Regardless of debris, all bits cut a clean-edge hole.



FORSTNER BIT chucked in a drill press can drill large holes with flat bottoms diagonally in work pieces. Bit won't deflect as it enters wood.

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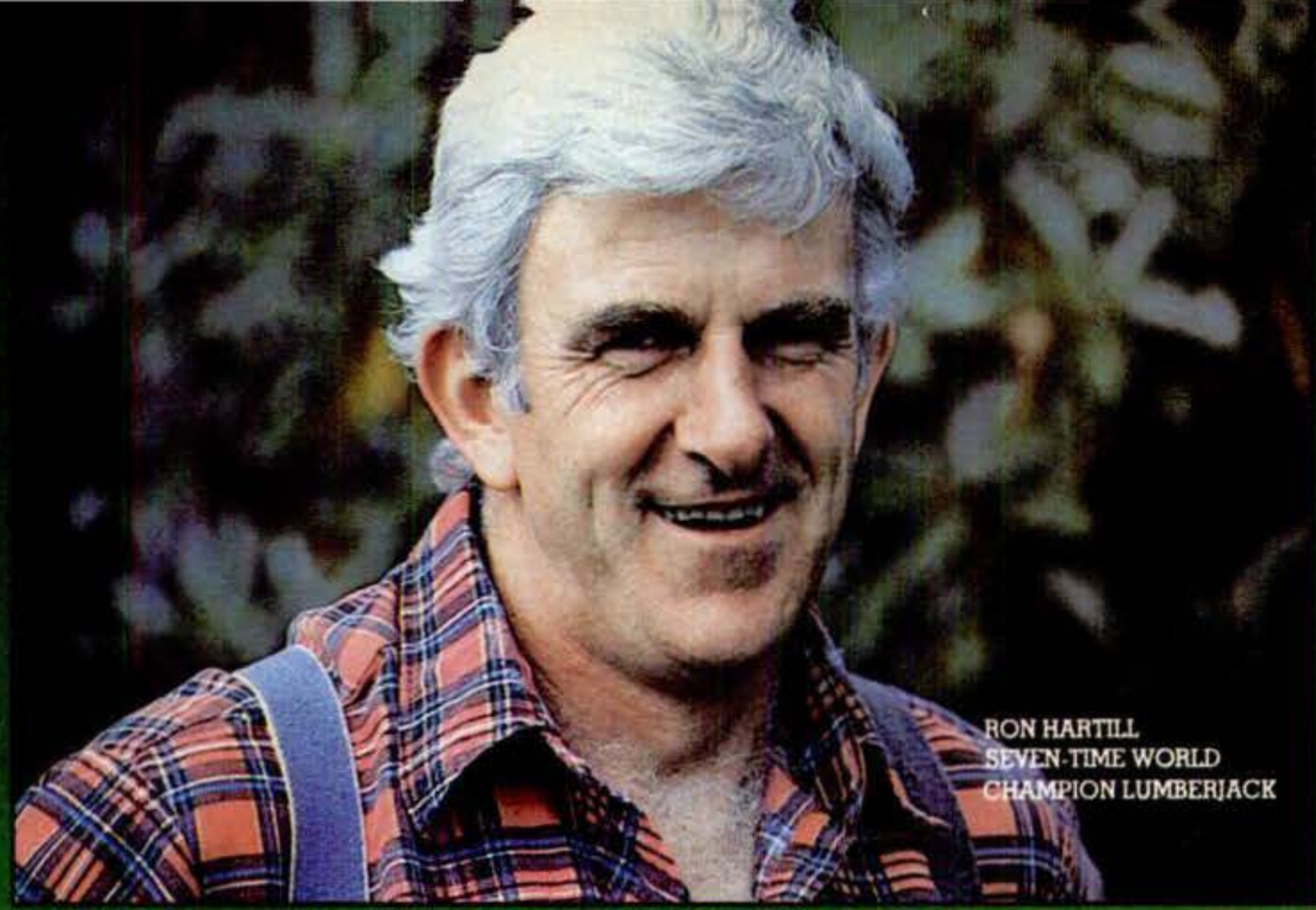

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out the wood. The brad-point drill is the best all-around choice for making clean holes in wood. It's best used on a drill press, but can also be used in a portable electric drill.

Forstner bits. Use these relatively expensive bits when you want to drill an especially clean hole partway through the wood without the risk of the spurs or feed screw of an auger bit (or the tip of a brad-point bit or twist drill) going deeper and possibly breaking through. The hole made by a Forstner bit is exceptionally clean and has a flat bottom. Its brad point is typically only 3/32 inch long. Flat-bottom hole drilling is important when drilling holes for dowels in thin boards. A Forstner bit can also drill partial-diameter holes—holes slanted into the side of a board, as for screws holding a table top to an apron. The Forstner bit is for wood only; you must use a drill press; and the work, except for full-diameter straight drilling, must be firmly clamped.

Multi-diameter bits. Having on hand a set of twist drills to handle all possible drilling needs in metal, plastic, and thin wood between 3/8 inch and one inch would be expensive. A plumber's tapered burring reamer is one solution to the problem, if you have a bit brace. However, maintaining accurate hole location and diameter is difficult because the tool is very fast-cutting in soft or thin materials. Arco's multidrills are single-flute tapered reamers. They are more controllable, and maintaining accurate hole location is easier. When you use the bit in a drill press, hole diameter can be accurately controlled with the depth stop.

A Unibit is the best approach to a multidiameter bit. It's a step drill with diameters in 1/16-inch increments. If you can work from both sides of the material, straight-sided (not tapered) holes can be drilled in material up to 1/4 inch thick. Working from one side only, the limit is 1/8 inch. Even when drilling with an electric hand drill you can count steps for repetitive drilling of the same-size holes.

Expansive bits. Bits for braces are made up to No. 24 (1½ inches), and the bigger ones are expensive. A pair of expansive bits can take the place of a set of auger bits when you need holes over 5/8 inch in diameter, and can be used to bore holes up to three inches. When setting an expansive bit, always check the hole size in scrap first. Don't trust the calibration. And always be sure the cutter locking screw is as tight as you can get it.

Hole saws. There are two kinds. The inexpensive type comes with a single mandrel and a set of seven blades. The blades resemble pieces of wide hacksaw-blade stock formed into circles. The advantage of low initial cost is offset by not being able to replace worn blades individually.

In the better type of hole saw, the blade is in the form of an inverted cup with teeth around the rim. The cup mounts on a mandrel. Blades and mandrels are purchased separately, although they are sometimes available in kits. Use high-speed steel blades on wood, machinable steel, iron, brass, copper, aluminum, and most plastics (except fiberglass-reinforced and thermoplastic). Carbide-tipped hole-saw blades cut all of the above materials, plus fiberglass-reinforced plastic, gypsum board, and plaster (but not masonry).

Both types of hole saws have twist-drill pilot drills. Use either of them in a drill press or portable electric drill. When drilling deep holes it's a good idea to back out the drill occasionally and chisel out the scrap material. The saw runs cooler with less chip clogging, and you won't have the time-consuming problem of getting the plug out of the saw cup when you're finished.

Lock-set bits. The most common need for a large-diameter wood bit around the house is for installing a new lock set on a door. You can make the large hole in the

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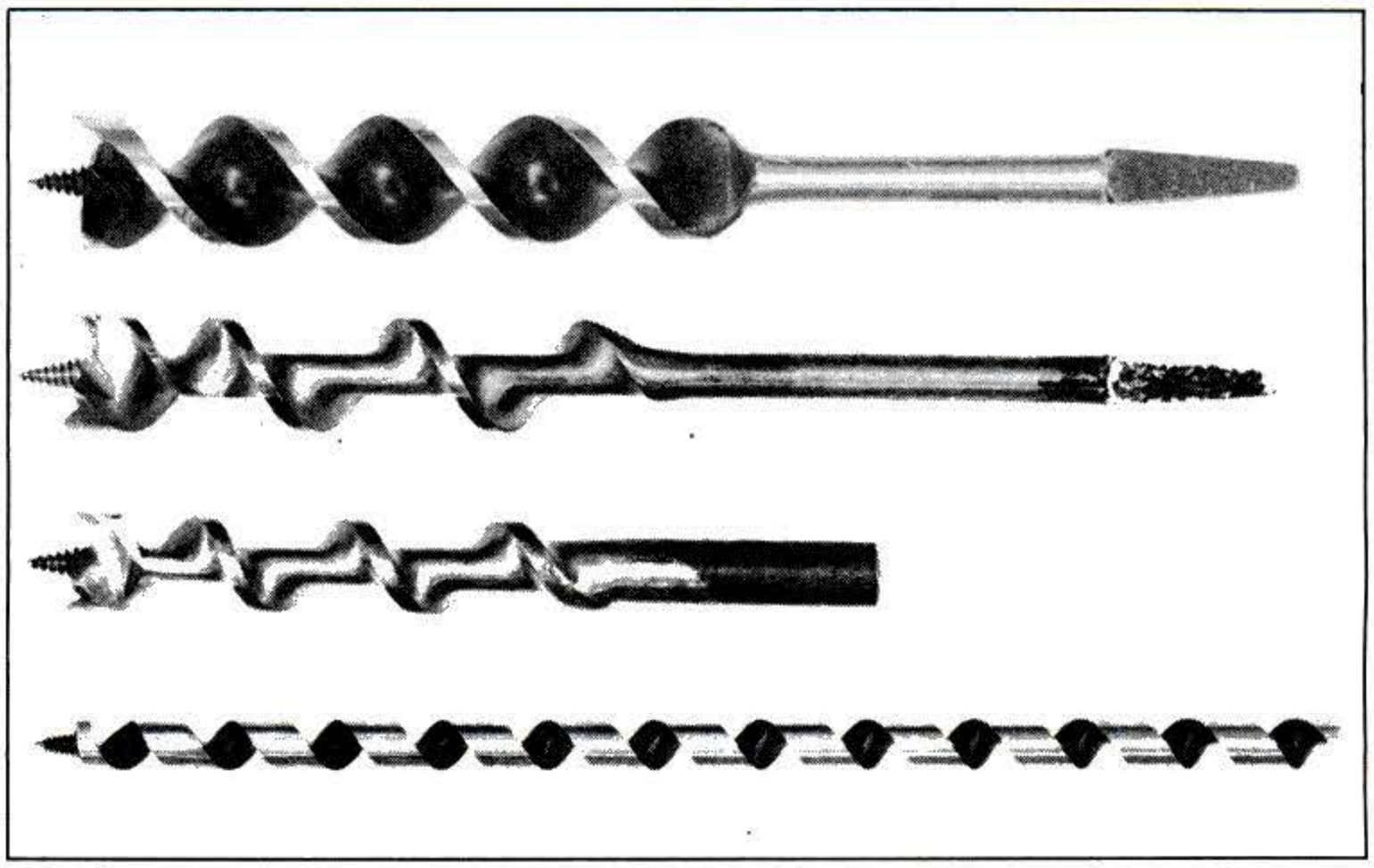

AUGER BITS, from top, are double-spiral Russell Jennings, solid-center auger, solid-center auger with straight shank for drill presses, ship auger (without spurs for a flat-bottom hole).

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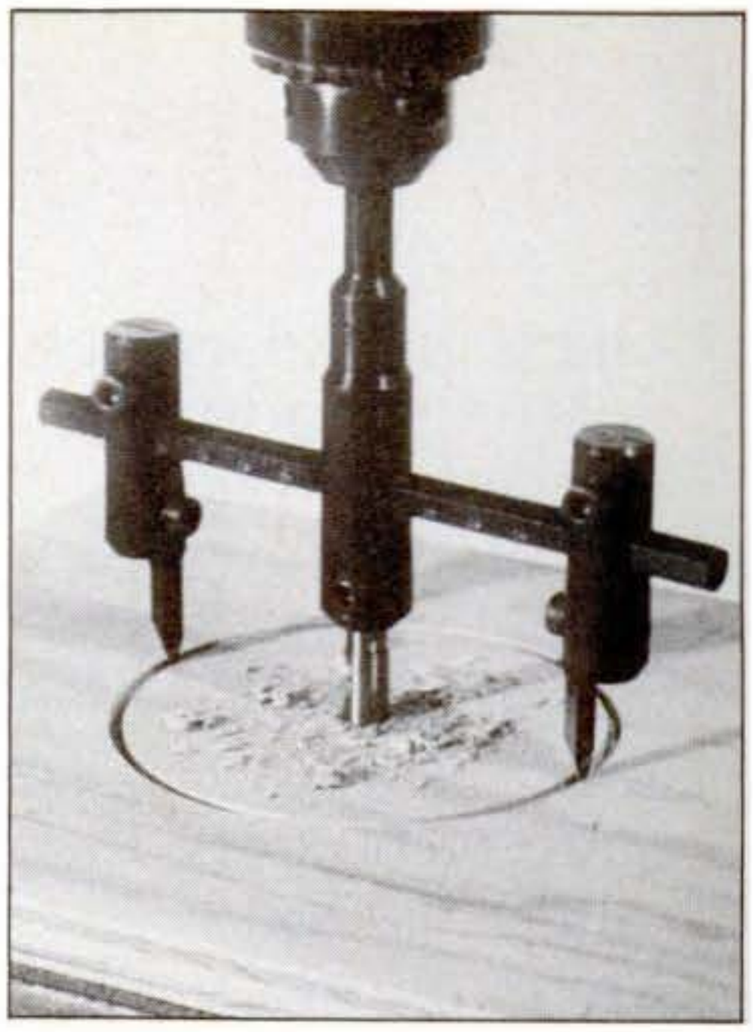

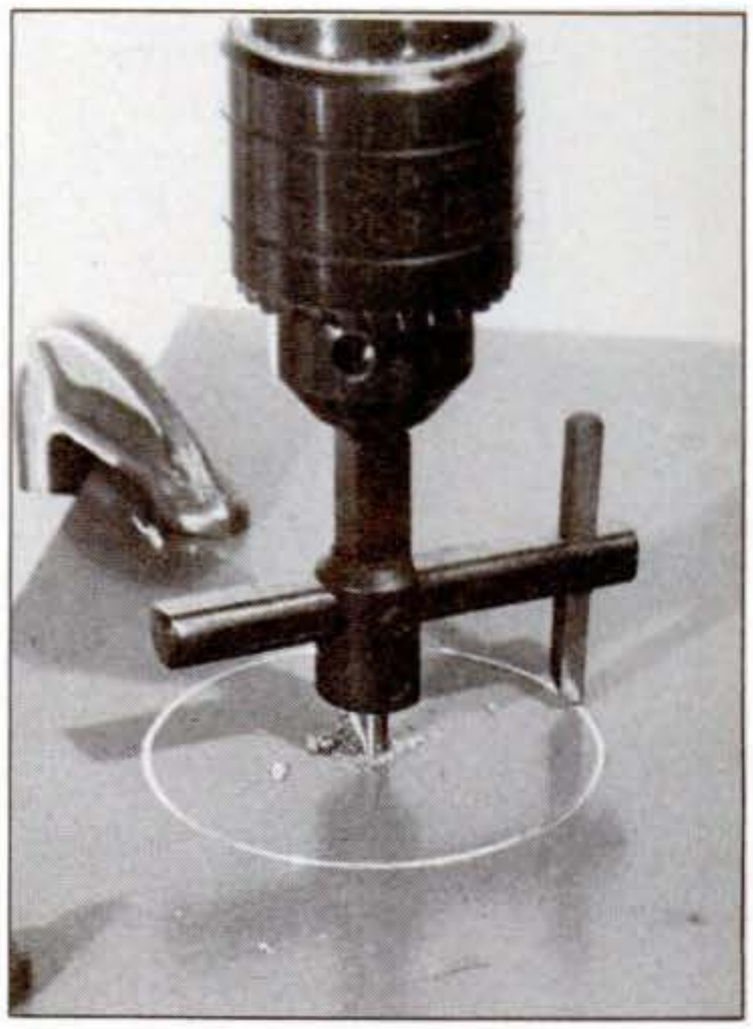

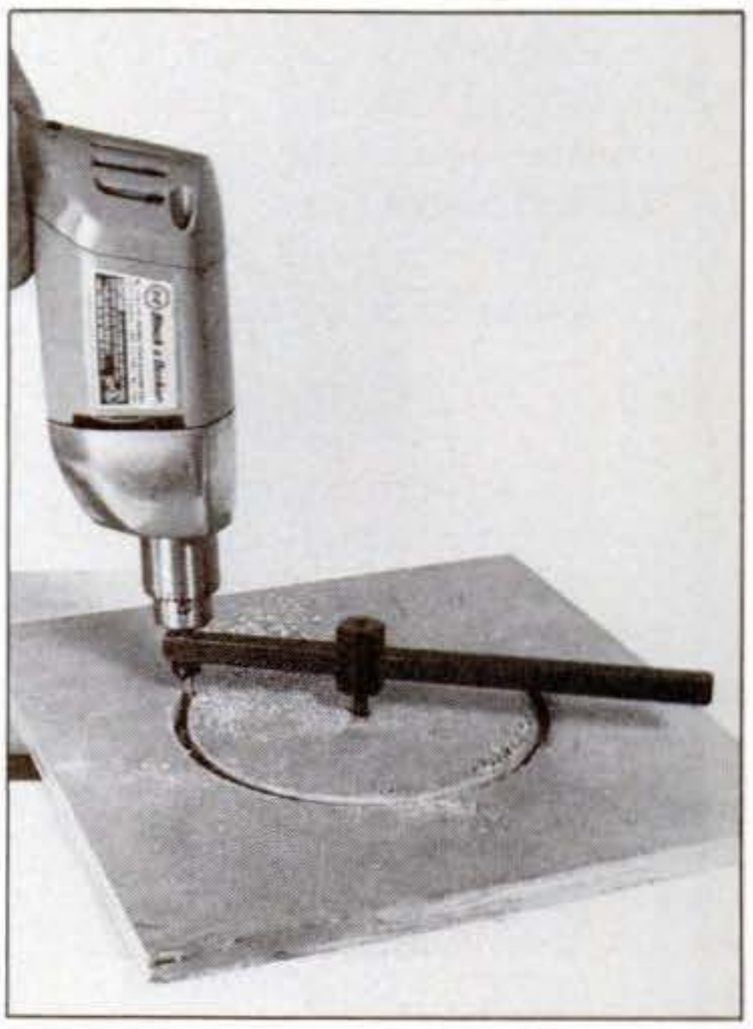

CIRCLE CUTTER from Brookstone (top) cuts a ⅛-in. kerf, good for thick material. General's cutter (center) works best with thin material. Compass Cutter (bottom) from Hit Products works with a portable drill; its bit acts as a saw.

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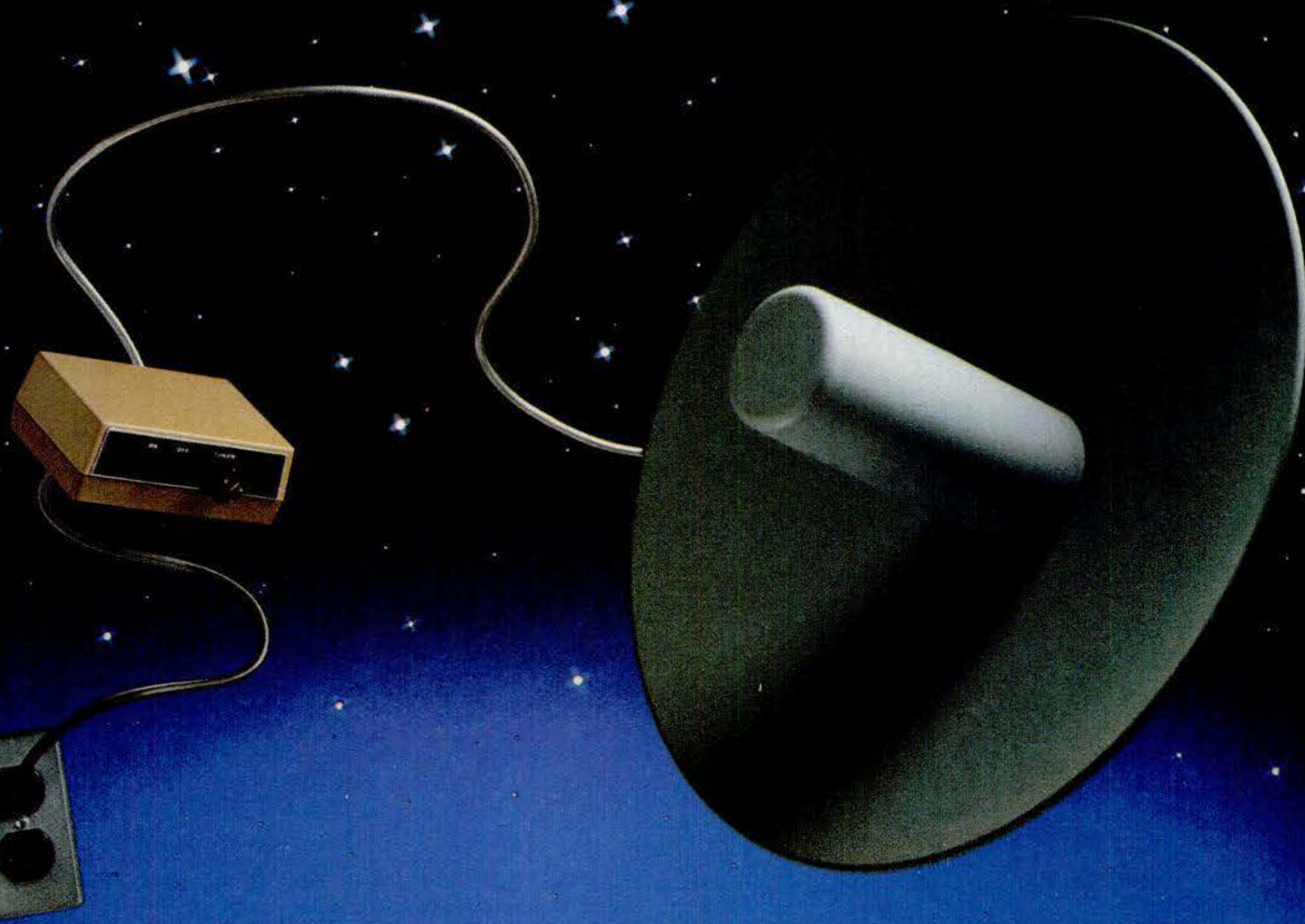

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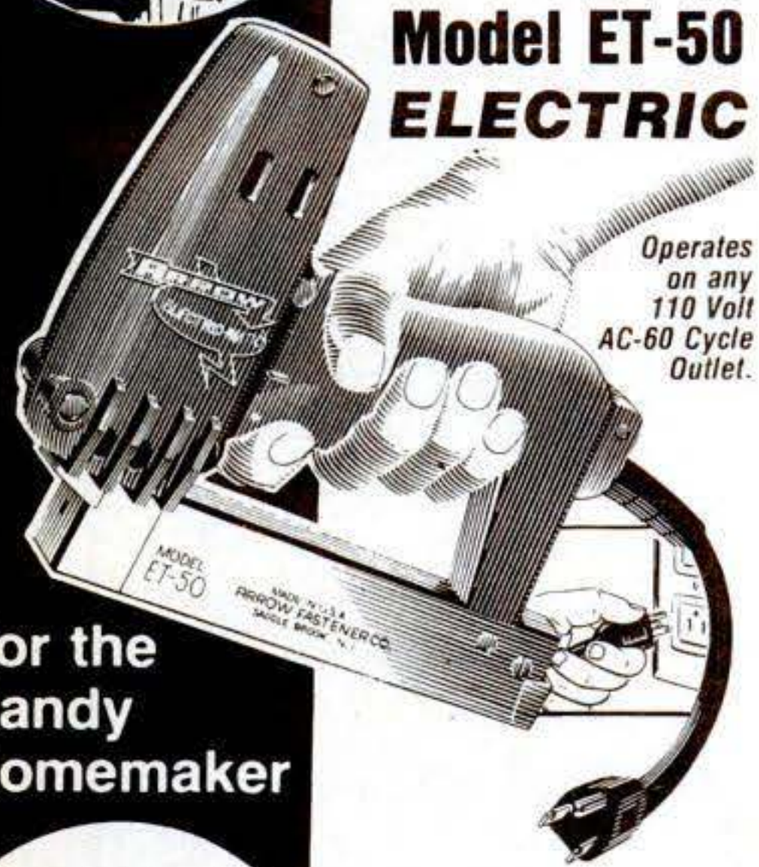

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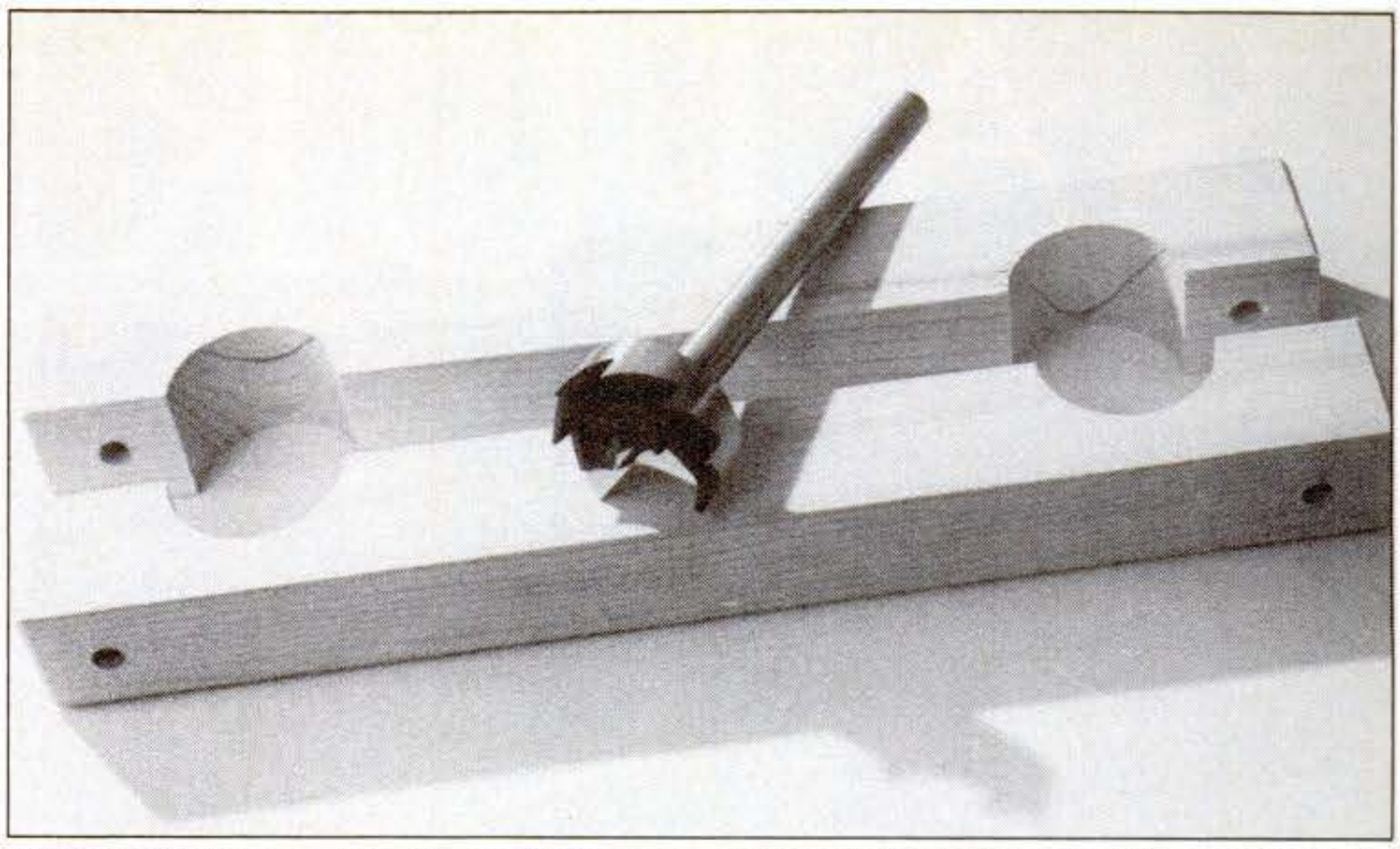
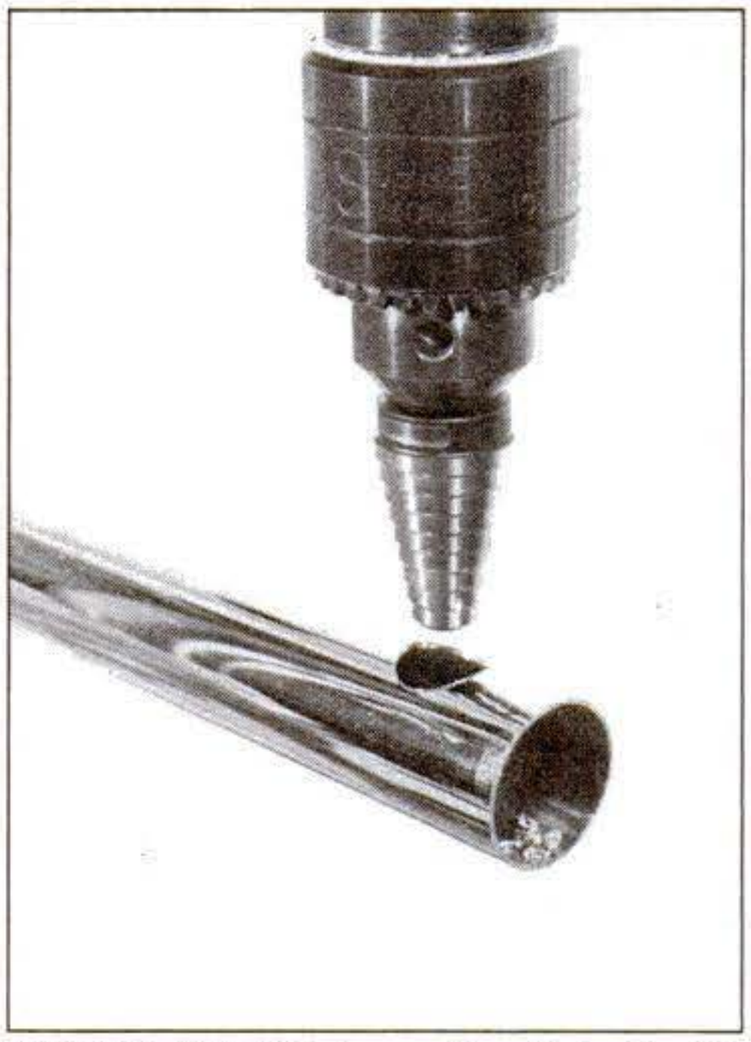
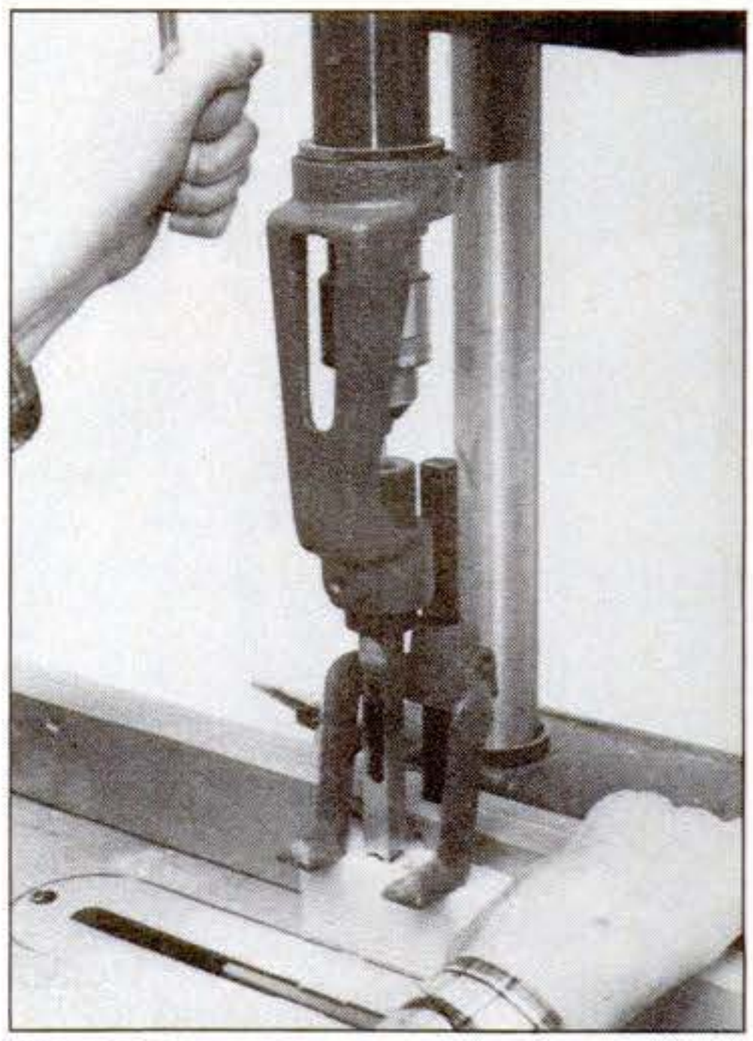


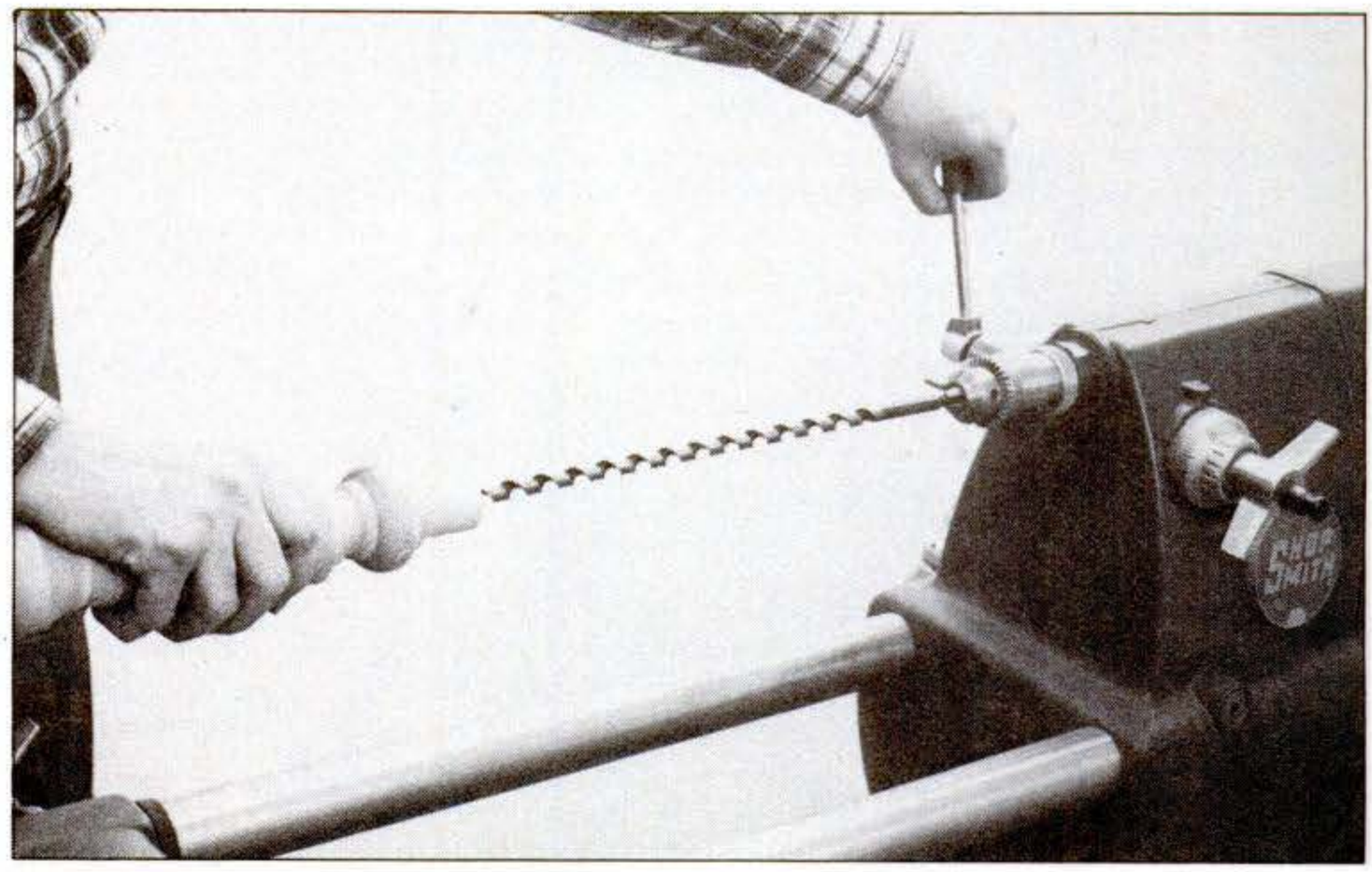
MULTI-SPUR BIT is used to drill exactly located holes in clamped wood. Performance is comparable with that of Forstner bit, except for the larger point. Bits range from ½ to 2⅛ in. dia.



UNIBIT STEP DRILL bores clean holes in thin material easily. Tubing can be drilled without clamping—the bit has no tendency to walk.



MORTISING BIT for drill press bores a round hole, and the chisel squares it. Considerable downward force is required for chisel to cut.



SHIP AUGER is used for boring deep holes, such as a run for an electrical wire in a wooden lamp, above. The bit shown has a tapered feed screw, and the length of the twist section is 12 in.

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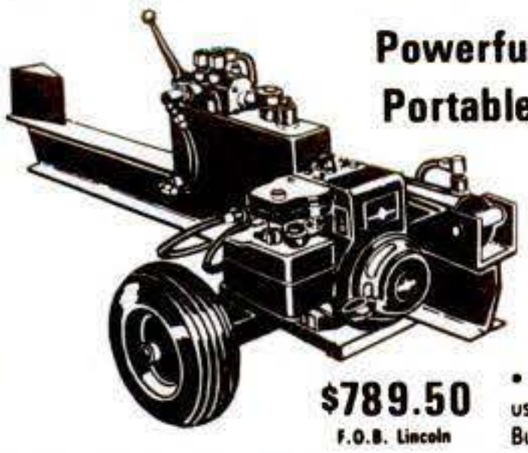

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How to drill big holes

[*Continued*]

side of a door in a number of ways: You can use a hole saw; if you have a bit brace, you can use an expansive bit; if you have a lot of doors to do, you might use a special door-lock bit or a lock-set bit. If you have a drill press, you can use a hole saw, lock-set bit, or multi-spur bit. (Multi-spur bits can drill semicircular holes, just as the Forstner bit can.)

Circle cutters. Also known as fly cutters, circle cutters are used in a drill press for making large-diameter holes in metals, plastics (except fiberglass-reinforced), and wood. Work should be clamped and backed with scrap plywood. For a clean hole, cut partway from one side and finish from the other. Your drill-press speed should be slow, and the feed should be extremely slow.

A variation of the fly cutter is Hit Products' Compass Cutter, which chucks into an electric hand drill. It can cut circles up to 18 inches in diameter using a special cutter bit. The bit travels a line set by an adjustable arm tethered in the center of the cut. Use the tool for either cutting a large circle in plywood, plastic, etc., or for cutting out a disc. It will cut through a 2×4.

Deep-drilling bits. Extra-long twist drills, brad-point drills, and auger bits are for boring very deep holes, such as in turned lamp parts. Of the three, the brad-point drill is the most accurate with the auger second. Use a slow drill speed and slow feed. For drilling holes in several diameters, do initial boring with a brad-point drill for accuracy, then ream with twist drills for larger diameters to save the cost of buying several expensive bits.

Mortising bits. A mortising bit drills a square hole. Use these to make mortises for tenons. You make rectangular holes by drilling overlapping square holes. The mortising bit consists of an end-cutting drill rotating inside a hollow square chisel. A special attachment clamps the chisel to the drill-press quill. The drill is chucked normally. Precise adjustment between the drill and the chisel is essential, and the chisel must be honed razor-sharp for the mortising to work at all. To drill the square hole, you have to bear down; the drill cuts a round hole and the chisel squares it. A hold-down restrains the work as you bear down and release. The advantage? You can make a lot of mortises fast, once the machinery is set up.

Drilling a big hole doesn't have to be a big project. If you have any doubt about how the hole will turn out, practice on a scrap piece of material similar to that of the project. You could save yourself a lot of grief later. PS

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Fall Home Value Ideas

Calculating your paint needs

Planning to paint your house? One of the first things you have to do is estimate how much paint you'll need. In most cases, the paint-can label will tell you the number of square feet the can's contents will cover, depending on the type of surface—primed, porous, or unpainted. Corrugated surfaces require more paint, as do areas of the house with narrow siding.

Your main task, then, is to determine the square footage of the area you'll be painting. Once you know that figure, you divide it by the area each gallon of paint will cover to determine the number of gallons you need. For example, if you have 5,000 square feet of surface to paint and each gallon you buy covers 400 square feet, then you'll need 12½ gallons of paint for the job.

How do you figure the total square footage? According to specialists at PPG Industries (One Gateway Center, Pittsburgh, Pa. 15222), it depends on how many oddly shaped areas are to be coated. For walls, ceilings, floors, or doors, you simply multiply width by length (or height) and add the totals. For gables, measure the width of a gable end of your house, then multiply that result by one-half the gable height.

You can determine a gable's height by multiplying the roof's estimated percentage of slope (a flat roof is zero percent, a perpendicular line is 100 percent) by the gable width. For example, a gable that is 25 feet wide and has a roof that slopes 25 percent has a gable 6.25 feet high.

You multiply half the height (6.25÷2=3.125) by the width (25), and you arrive at an approximation of the area of the gable end: 78 square feet.

For irregular areas, you need special formulas. Here are recommendations for figuring square footage for various exterior features:

- Plain cornices: Multiply length by width and double the result. For ornamental cornices, triple the result.
- Plain eaves: Multiply the width of the overhang by the length and add 50 percent. For eaves with exposed rafters, double this figure.
- Slatted shutters or blinds: Multiply width by length and double the total for each face.
- Latticework and handrails: Multiply the height by the length and multiply the result by four. Use the same formula for balustrades.
- Rectangular columns: Multiply the width of one side by the height and multiply that figure by four.
- Round columns: Multiply the circumference by height.
- Fluted columns: Multiply circumference by height and add one-half of that result.
- Downspouts and gutters: Find the circumference in inches, divide by 12, and multiply by the total length (in feet) of each piece. Double the result if you're planning to paint the gutters inside and out.
- Picket fences: Multiply the height by the length and multiply the result by four. This gives an approximation for both sides.

Deduct the area of any feature that's not to be painted, such as patio doors, windows, or brickwork.—*Charles A. Miller*

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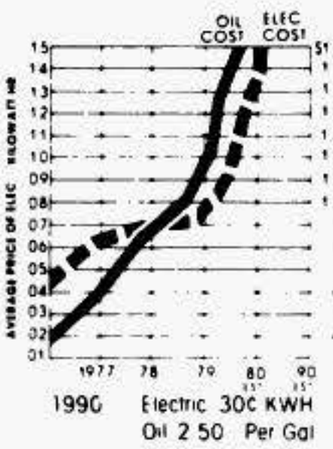

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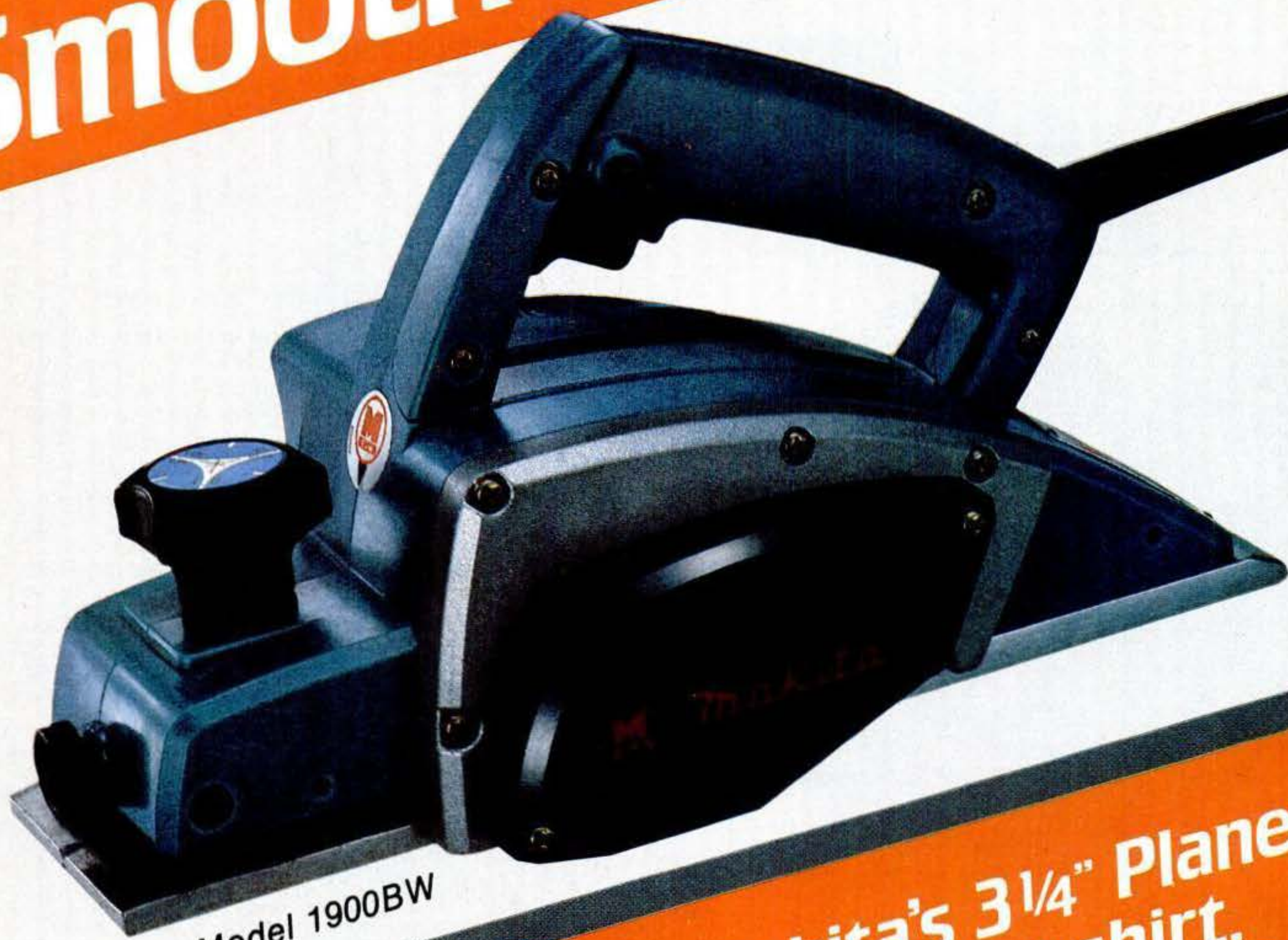

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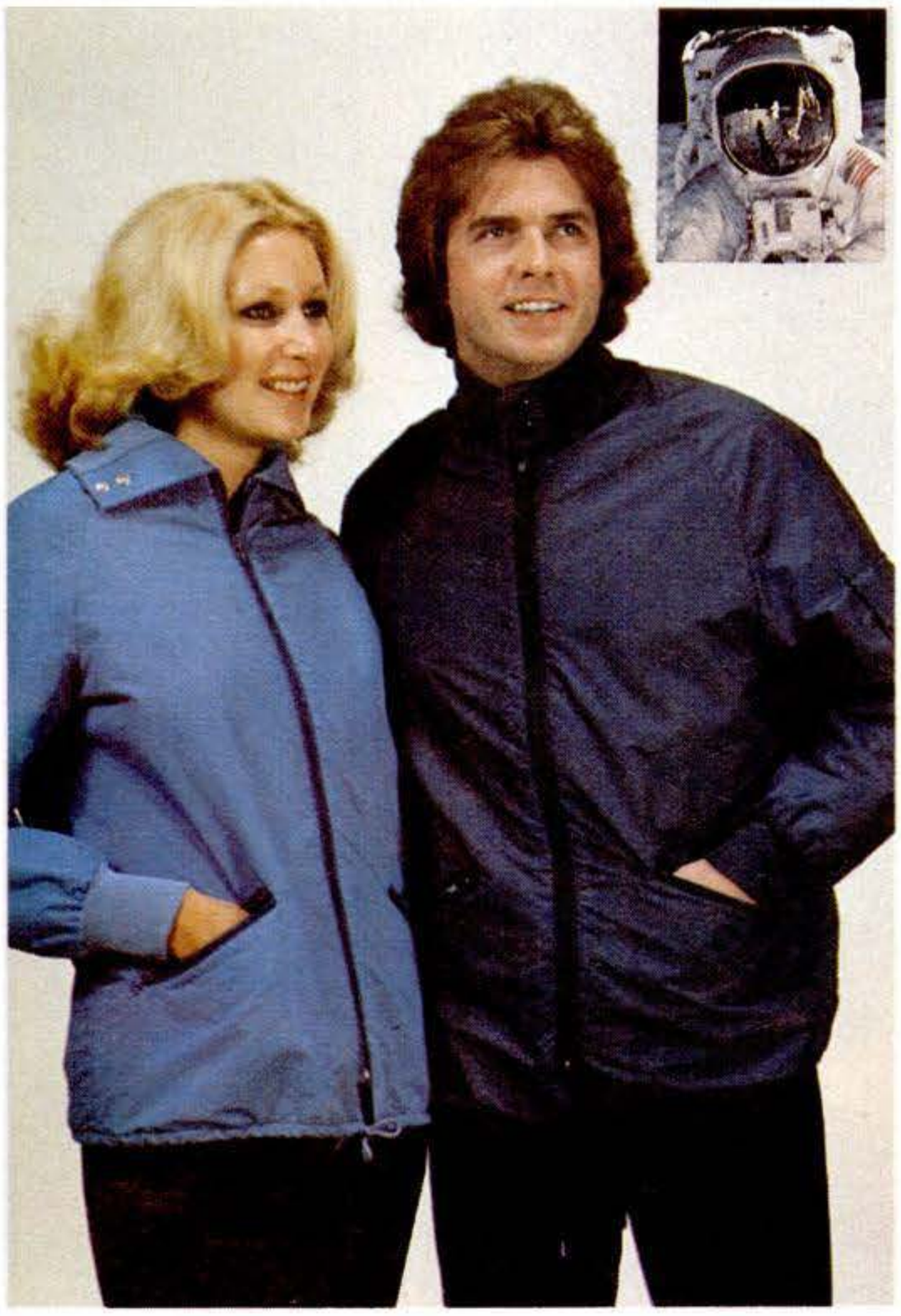

From the same technology which insulated man in outer space comes a new type of garment...

SUPERJACKET II

The Action Jacket for people on the go!

You are invited to test wear it free for 15 days.

THE SUPERJACKET'S miracle lining is the same type of material that was developed for the space program. It keeps body heat in, cold out — without bulk or weight. You'll love the fantastic freedom you'll feel when you toss on this smart-looking, versatile jacket to run to the store, play a game of golf, land a whopper on a fishing trip... or just putter in your back yard. It's so incredibly light in weight you won't believe how toasty warm it keeps you — even when the temperature plunges!

You no longer need a wardrobe full of jackets for different seasons. The Superjacket II takes you through all of them — spring, summer, fall and even winter — in absolute warmth, comfort and style. It's the one jacket you'll reach for again and again... the one you'll take along on trips, when you're not sure what the weather will be like... and the Superjacket II folds compactly... takes up just a small corner of your suitcase.

What's more, it's 100% water-repellent, so you can wear it in rain, snow, sleet, fog — a feature that won't wash out no matter how many times you toss it in the washing machine and tumble-dry it. And because it's washable, think of all the money you'll save in cleaning bills.

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The first at-home training in videocassette recorder repair with exclusive videotaped lessons.

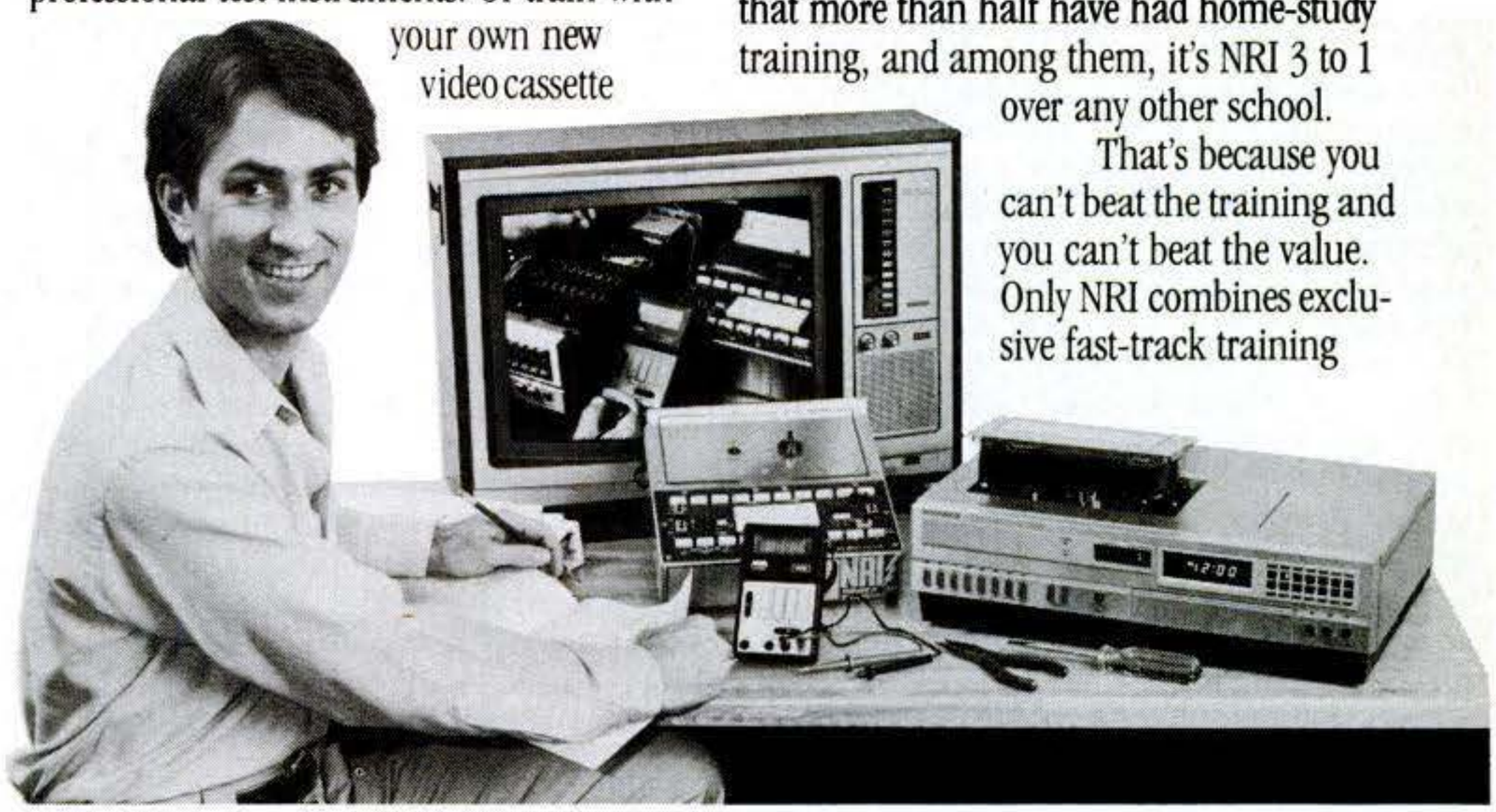
Learn TV/Audio/Video Servicing...includes state-of-the-art VCR, NRI Action Video lessons, plus full training in color TV and audio repair.

Now, you can learn the hottest, most wanted skill in home entertainment electronics...servicing and repairing videocassette recorders and video disc players. Well over 2 million units have already been sold and the demand is just starting! Already, qualified VCR technicians are in short supply...people are waiting up to a month for VCR repair. Good jobs at good pay are going begging. And NRI can get you in on the action with convenient and effective at-home training.

Choice of Specialized Training

NRI offers you three Master Courses in TV/Audio/Video Servicing, each complete, each with equipment and training for the specialty you want. Each course thoroughly prepares you for color TV plus audio and video equipment. Then, you take the specialized hands-on training on the equipment you select.

You can get specialized audio experience as you build your own AM/FM stereo system complete with speakers. Or gain real bench experience with hands-on TV training as you build a 25" (diagonal) fully computerized, programmable color TV and professional test instruments. Or train with your own new video cassette recorder and NRI's exclusive Action Video servicing lessons on videotape.



Specialized training on Heath/Zenith Model 2501 25" (diagonal) color TV, videocassette recorder, or AM/FM stereo you keep for yourself.

State-of-the-Art VCR

This modern VCR features high-technology design with electronic pushbutton tuning, remote control, three recording speeds with up to 6-hour capacity, high-speed visual search, built-in clock/timer, memory rewind and audio dubbing capability. Direct drive motors and azimuth recording give outstanding picture reproduction.

It's yours to keep, as part of your training. You'll not only use it to learn operation and servicing techniques, but to play the absorbing NRI Action Video lessons that come as part of your specialized training. In word and picture, you'll learn theory, construction, and service procedures, see them explained in graphic closeups. And you get this unique training only with NRI!

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No need to quit your job or tie up your evenings at night school. No time away from your family or expensive travel. NRI comes to you. You are a class of one, getting both theory and practical hands-on training backed up by our staff of experienced educators.

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More than 67 years and a million and a half students later, NRI is still the first choice in home-study schools. A national survey of successful TV repairmen shows that more than half have had home-study training, and among them, it's NRI 3 to 1 over any other school.

That's because you can't beat the training and you can't beat the value. Only NRI combines exclusive fast-track training techniques with modern state-of-the-art equipment to give you the skills you need for success quickly and easily. Only NRI offers such complete training with so many timely options for specialized bench experience. Send for our free catalog and get all the facts on these exciting Master Courses in TV/Audio/Video servicing.

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SHOP TALK

By AL LEES

Surviving another howler

All my items in this month's space address aspects of keeping the home cozy through the winter ahead.

I've been receiving requests for a final comment on urea formaldehyde foam—the highly touted "retrofit insulation" of the mid-'70's, the "shaving cream" that franchised applicators pumped into the empty stud cavities of older homes, where it expanded and solidified. The stuff had been used for years in commercial applications in Europe, so when it became available for use in homes here, we ran two feature articles on such installations. The writers of both these articles still live happily in those houses, yet the urea formaldehyde-foam industry is now dead—killed by a ban imposed by the Consumer Product Safety Commission that has just taken effect.

Out of over 500,000 homes in the U.S. in which UF foam had been installed, the CPSC came up with only 2,200 complaints, so it's still safe to say that wherever UF was properly mixed and applied it not only did an effective insulating job, it caused no outgassing problems. Still, a few of the complaints involved severe reactions, and there's even been a suggestion that formaldehyde gas, at high concentrations, may be a carcinogen.

Since the cost to remove the installed foam can range from $4,000 to $20,000 (depending on the size and complexity of the structure), hundreds of homeowners across the country have sued manufacturers and installers, and the tide may threaten makers of other products containing formaldehyde (such as particleboard) that the ban doesn't cover.

The CPSC continues to say there's no cause for alarm—especially since the announced ban has driven most UF companies out of business and no new installations have been made this year. If your home had the foam pumped into its walls over a year ago and you've noticed no irritation or dizziness, you needn't worry.

But if you're still concerned about formaldehyde levels in your home, you can test for fumes. A commercial lab might charge you anywhere from $50 to $500 (check your Yellow Pages, local environmental agencies, or health departments). But 3M now sells a metering device for DIY testing. The $35 price includes 3M's lab analysis and report after you've exposed the meter in your home for 24 hours and mailed it back to them (it's not reusable). Write 3M Co., Box 43157, St. Paul, Minn. 55164.

As for the cancer fear, I especially recall one reader's expression of concern: A New England woman phoned to ask my evaluation of the UF-foam question. Seems her husband, impressed with our reports, had the foam installed in their uninsulated, late-'30's house. This couple had been delighted with the increased comfort and lower fuel costs. But their friends warned them that they risked cancer by living there.

I carefully explained that any release of gas had ended with the curing of the foam in the walls—and, besides, the American Cancer Society had announced there was no evidence that formaldehyde fumes can cause cancer in humans. I went on to say that several companies that use formaldehyde in manufacturing processes are conducting studies of worker exposure and so far (Du Pont's report is complete) have found no statistical indication of unusual incidence of cancer in people who work with formaldehyde regularly.

As I spoke, my concerned caller interrupted to say: "Would you hold on just a minute? I can't reach my cigarettes."

For the first time in 20 years, I hung up on a PS reader.

DIY solar collectors

The National Solar Heating Workshop concept was first developed at Arizona State ["Solar for Credit," PS, June '80]: Homeowners enrolled (at a nominal tuition) for a one-day assembly workshop that gave hands-on experience in constructing a solar water heater. If you then wished to complete and install the unit at home, you paid for the parts you carried away. The program has now spread to New England. For further data contact The Back Forty, Box 157, Buckfield, Maine 04220. This store stocks all parts for two-, three-, or four-panel kits.

If your interest is in an air system for space heating, write Solar Innovations, Box 6788, Great Falls, Mont. 59406. It claims to have devised a uniquely channeled collector (of efficiency superior to most manufactured units) that can be built by anyone in a few hours for under $175. Plans and instructions are $40; kits are $375; a fully assembled unit is $475.

Every little saving helps

Several years back, nearly everyone that could tap into a natural-gas line installed at least one outdoor gas lamp. The nostalgic charm has dimmed by now with rising fuel costs, so Sears is offering an install-it-yourself conversion kit. You electrify your gas lamps with a photoelectric socket that replaces the existing gas mantle; it turns the bulb on at dusk, off at dawn. The

kit costs $50 (at Sears retail stores), but consider typical operating costs: The gas lamp, burning continuously, would cost about $75 a year to operate, while the low-voltage one—averaging 11 hours of on-time daily—would cost under $10.

Heat-capturing house

Does the picture above look familiar? Regular PS readers will recognize this house as one we ran in our leisure-home-plan series [PS, April '81]. It featured a unique system of built-in vertical solar collectors set between windows on the south wall—a heated-air system designed and tested for PS by architect Samuel Paul. This snapshot was sent to us by owner-builder Henry Baillie, who'd bought the plans and finished the house this past spring—on a private lake in Illinois. Reader Baillie writes: "I studied a lot of house plans before selecting this one," and he's looking forward to a very cozy winter. The plan is still available from Homes for Living, Inc., 107-40 Queens Blvd., Forest Hills, N.Y. 11375; ask for the Ridgewood Plan.

Heating-appliance problem?

If it's a GE heat pump, you may be in luck. The company has just announced a nationwide consumer hot line where you can place a toll-free call 24 hours a day, every day of the year, for information about *any* GE or Hotpoint product—from light bulbs to refrigerators.

As a follow-up to GE's Quick Fix system of how-to-repair manuals and replacement components for the five major kitchen and laundry appliances, the new Answer Center puts the company in the forefront of consumer service. Quick Fix racks in home centers have been very successful, and I predict the Answer Center will prove equally popular. Here's the number that will put you in touch with the staff in Louisville: (800) 626-2000.

Other companies are becoming more responsive to consumer complaints, too, according to a free booklet you can get from Coca-Cola, "How to Talk to a Company and Get Action." Believe it or not, the larger the corporation, the more likely it is to welcome consumer input for its marketing programs. For your free copy write: Consumer Info. Center, Coca-Cola Co. Dept. CE, P.O. Drawer 1734, Atlanta, Ga. 30301.

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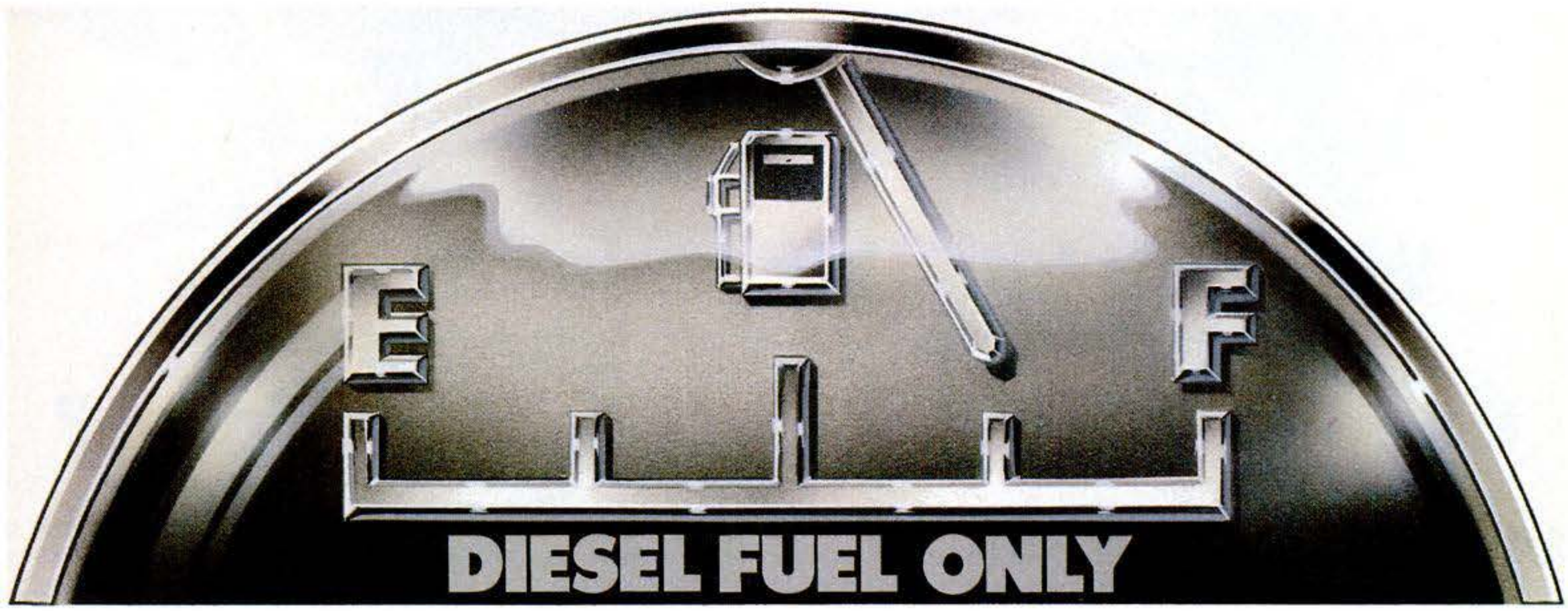
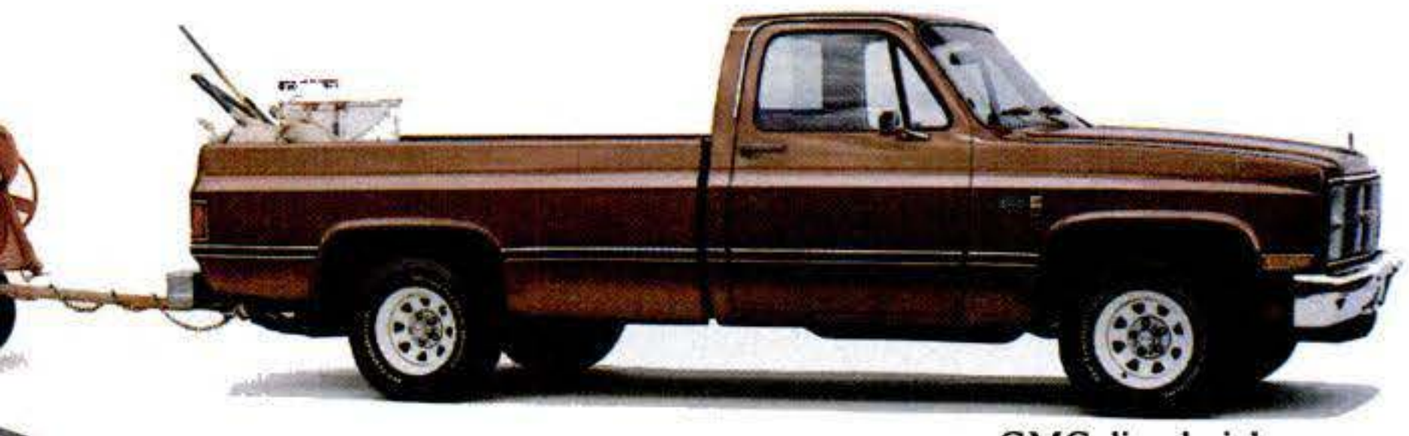
PUT ONE OF THESE GMC DIESEL TRUCKS TO WORK AND WATCH IT SAVE.

GMC is a division of General Motors.





GMC diesel pickup.

GMC diesel Suburban.

GMC diesel van.

GMC diesel Jimmy.

They're powered by an optional 6.2 liter truck diesel.

An engine that's built to do a truck-size job of hauling or towing. With the traditional diesel features of rugged construction and efficiency of operation. See the mileage estimates for GMC 2-wheel-drive, diesel trucks and the projected estimates for the 4-wheel-drive Jimmy below. Diesel power is also available in 4-wheel-drive pickup and Suburban models. See the full line of full-size diesel trucks at your GMC truck dealer. And, wherever you go, buckle up for safety.

2-wheel-drive diesel pickup	EST. HWY.	31	EPA EST. MPG	21
2-wheel-drive diesel Suburban	EST. HWY.	30	EPA EST. MPG	20
G2500 diesel van	EST. HWY.	30	EPA EST. MPG	20
4-wheel-drive diesel Jimmy	EST. HWY.*	27	EPA EST. MPG*	19

Use estimated MPG for comparison. Your mileage may differ depending on speed, distance, weather. Actual highway mileage lower. Estimates lower in California. Some GMC trucks are equipped with engines produced by other GM divisions, subsidiaries, or affiliated companies worldwide. See your GMC truck dealer for details.

*GMC projections of 1983 mileage estimates. See your dealer for actual EPA estimates.

Official Truck of the XXIIIrd Olympiad Los Angeles 1984

GMC

TRUCKS ARE WHAT WE'RE ALL ABOUT.

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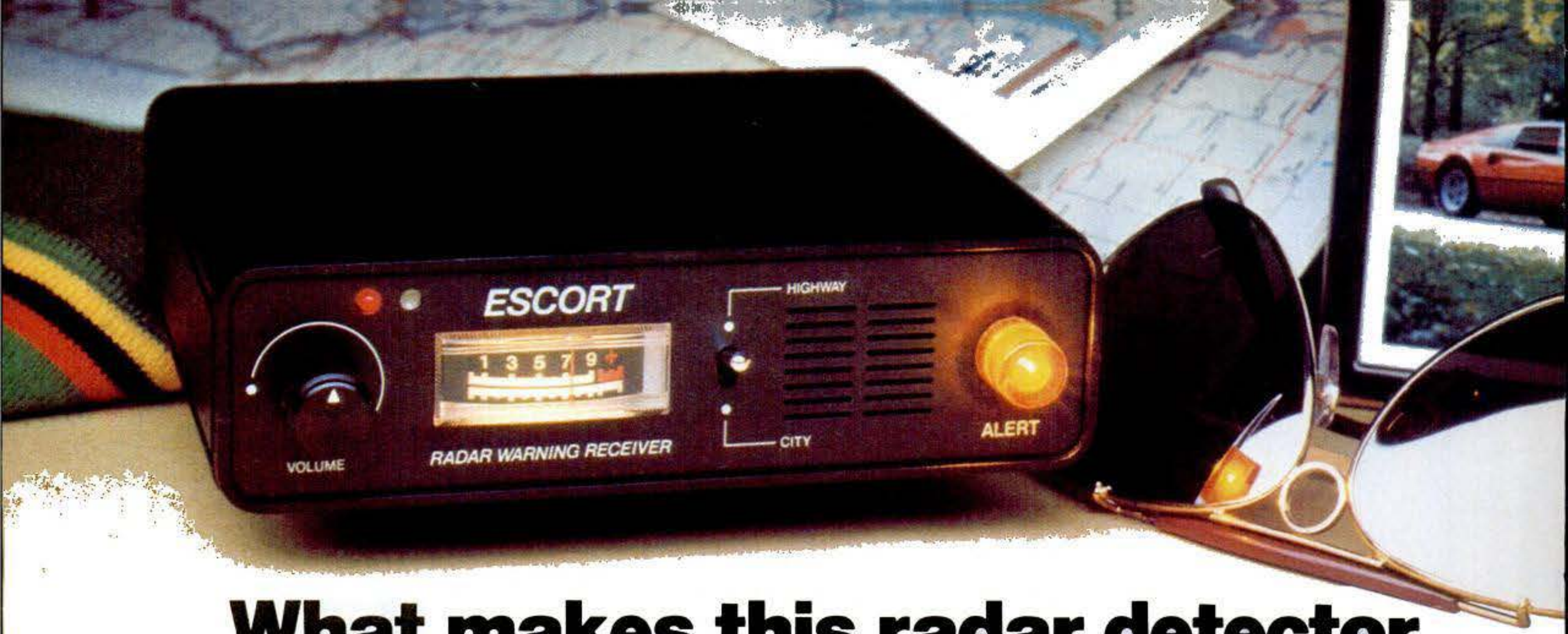

What makes this radar detector so desirable that people used to willingly wait months for it?

Anyone who has used a conventional passive radar detector knows that they don't work over hills, around corners, or from behind. The ESCORT* radar warning receiver does. Its uncanny sensitivity enables it to pick up radar traps 3 to 5 times farther than common detectors. It detects the thinly scattered residue of a radar beam like the glow of headlights on a dark, foggy road. You don't need to be in the direct beam. Conventional detectors do. Plus, ESCORT's extraordinary range doesn't come at the expense of more false alarms. In fact, ESCORT has fewer types and sources of false alarms than do the lower technology units. Here's how we do it.

The unfair advantage

ESCORT's secret weapon is its superheterodyne receiving circuitry. The technique was discovered by Signal Corps Capt. Edwin H. Armstrong in the military's quest for more sensitive receiving equipment. ESCORT's Varactor-Tuned Gunn Oscillator singles out X and K band (10.525 and 24.150GHz) radar frequencies for close, careful, and timely examination. Only ESCORT uses this costly, exacting component. But now the dilemma.

The Lady or The Tiger

At the instant of contact, how can you tell a faint glimmer from an intense radar beam? Is it a far away glint or a trigger type radar dead ahead? With ESCORT it's easy: smooth, accurate signal strength information. A soothing, variable speed beep reacts to radar like a Geiger counter, while an illuminated meter registers fine gradations. You'll know whether the radar is miles away or right next to you. In addition, the sound you'll hear is different for each radar band. K band doesn't travel as far, so its sound is more urgent. ESCORT keeps you totally informed.

The right stuff

ESCORT looks and feels right. Its inconspicious size (1.5Hx5.25Wx5D), cigar lighter power connector and hook and loop or visor clip mounting make installation easy, flexible, and attractive. The aural alarm is volume adjustable and the alert lamp is photoelectrically dimmed after dark to preserve your night vision. And, a unique city/highway switch adjusts X band sensitivity for fewer distractions from radar burglar alarms that share the police frequency while leaving K band at full strength.

Made in Cincinnati

Another nice thing about owning an ESCORT is that you deal directly with the factory. You get the advantage of speaking with the most knowledgable experts available and saving us both money at the same time. Further, in the unlikely event that your ESCORT ever needs repair, our service professionals are at your personal disposal. Everything you need is only a phone call or parcel delivery away.

Carrying case and visor clip included

Corroborating evidence

CAR and DRIVER . . . "Ranked according to performance, the ESCORT is first choice . . . it looks like precision equipment, has a convenient visor mount, and has the most informative warning system of any unit on the market . . . the ESCORT boasts the most careful and clever planning, the most pleasing packaging, and the most solid construction of the lot."

BMWCCA ROUNDEL . . . "The volume control has a 'silky' feel to it; in fact, the entire unit does. If you want the best, this is it. There is nothing else like it."

PLAYBOY . . . "ESCORT radar detectors . . . (are) generally acknowledged to be the finest, most sensitive, most uncompromising effort at high technology in the field."

PENTHOUSE . . . "ESCORT's performance stood out like an F-15 in a covey of Sabrajets."

AUTOWEEK . . . "The ESCORT detector by Cincinnati Microwave . . . is still the most sensitive, versatile detector of the lot."

The acid test

There's only one way to really find out what ESCORT is all about. We'll give you 30 days to test it for yourself. If you're not absolutely satisfied, we'll refund your purchase as well as pay for your postage costs to return it. In fact, try an ESCORT and any other detector of your choice. Test them both for 30 days and return the one you don't like. We're not worried because we know which one you'll keep. As further insurance for your investment, ESCORT comes with a full one year limited warranty on both parts and labor. This doesn't worry us either because ESCORT has a reputation for reliability. We know that once you try an ESCORT, radar will never be the same again. So go ahead and do it. Order today.

You don't have to wait

Just send the following to the address below:

- ☐ Your name and complete street address.
- ☐ How many ESCORTs you want.
- ☐ Any special shipping instructions.
- ☐ Your daytime telephone number.
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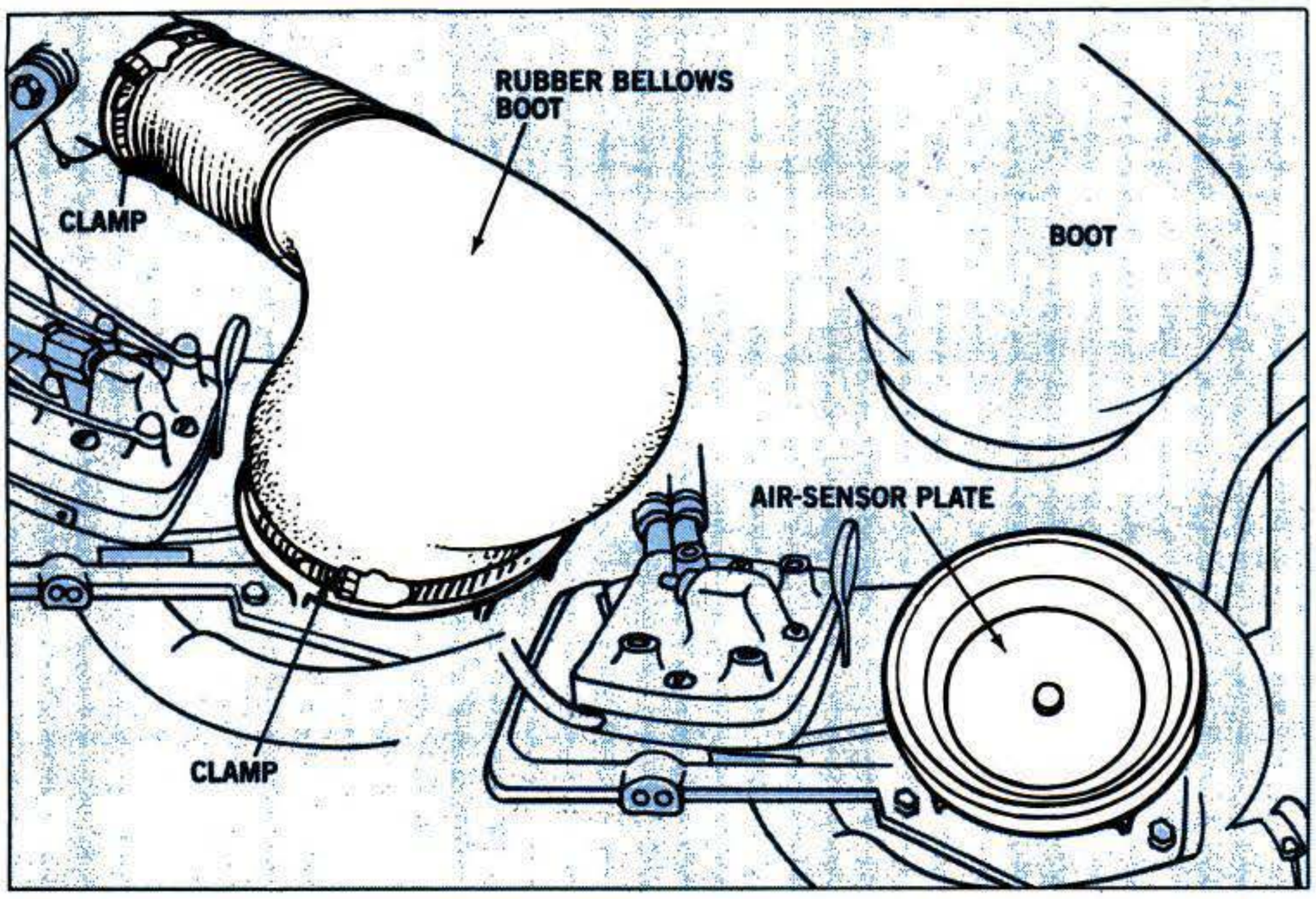
TAKING CARE OF YOUR CAR

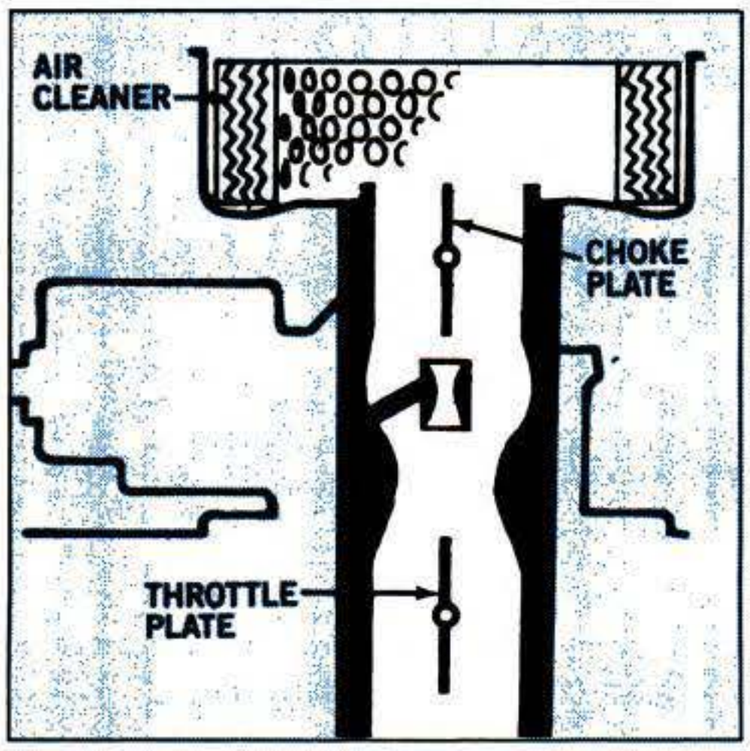
By STEVE MERCALDO

Got a useful car tip? Send it (with Social Security No.) to Car Care, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. We'll pay $50 if we use it. If two or more readers send the same tip, payment goes to the one with earliest postmark. No tips can be returned.



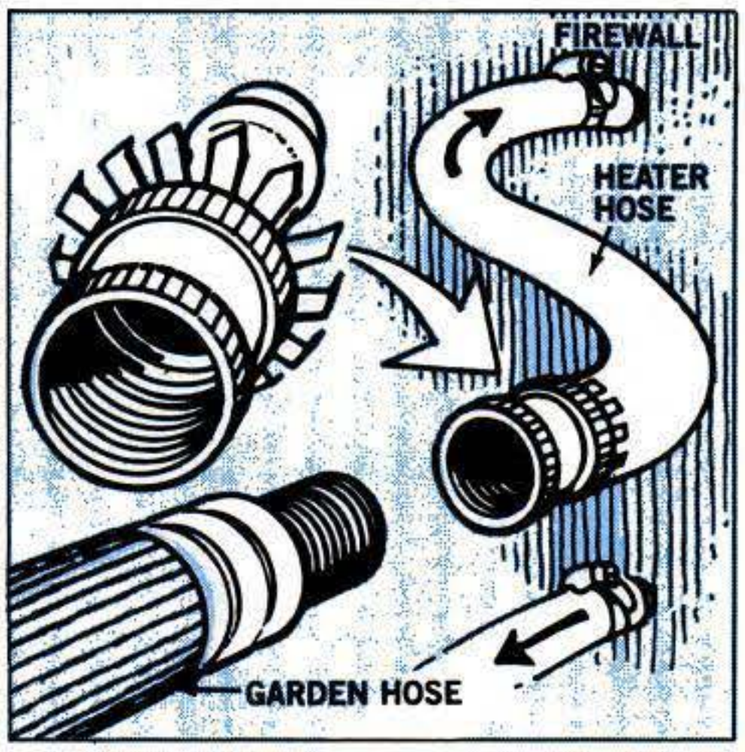
Smoothing fuel-injection idle

Engines equipped with K-Jetronic fuel injection use an air-flow-sensor plate to meter the fuel flow mechanically. Dirt buildup on the plate and surrounding air-sensor walls can cause a rough idle. The sensor plate is located under a large rubber or plastic bellows, which must be removed to clean the sensor plate. Loosen the two clamps that retain either side of the bellows, then carefully work the ends of the bellows off the air filter and venturi. Do not puncture or tear the bellows. An air leak would cause serious performance problems. Spray carb cleaner and allow the solvent to work. Wipe clean with a cloth. Reinstall boot and retaining clamps.



Engine lacks power

Inadequate throttle-plate opening can cause engine sluggishness and loss of power. To inspect for proper throttle operation, turn the engine off. Remove the air-cleaner assembly. Have an assistant push the accelerator all the way down. Look into the carburetor air horn or throttle body. The plate should be perfectly perpendicular. If it's not, adjust or repair the linkage to fully open the throttle.



Clogged heater-core remedy

If your car's heater blows cold air instead of warm, try back-flushing the heater core. Start by draining the coolant. Disconnect both heater hoses from the engine, and install a male adapter on the end of a garden hose so it can be inserted into the upper heater hose. Turn on the faucet and run water until the discharge from the other heater hose is clear. Reconnect the hoses, and refill the coolant.

Continued

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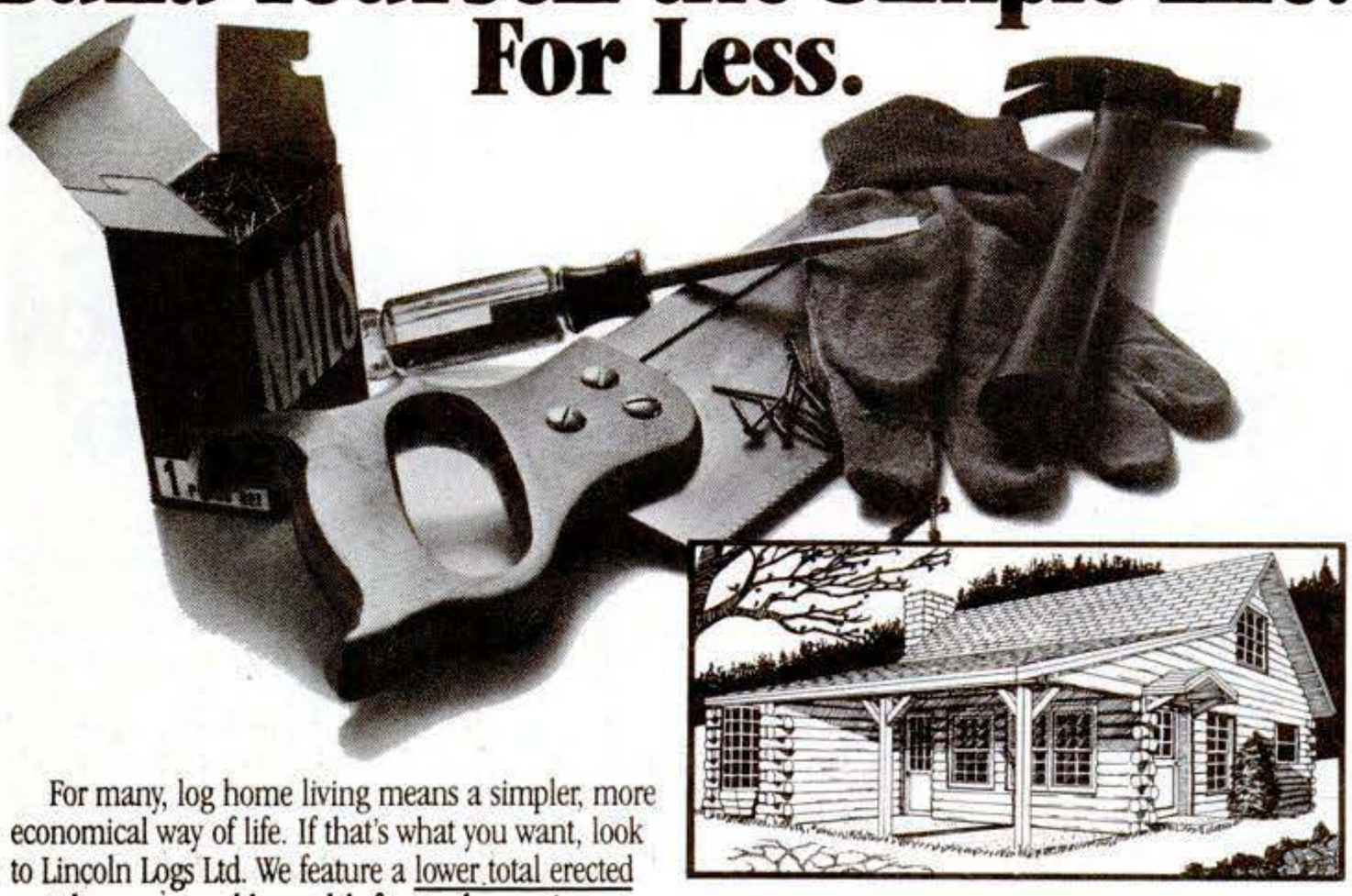

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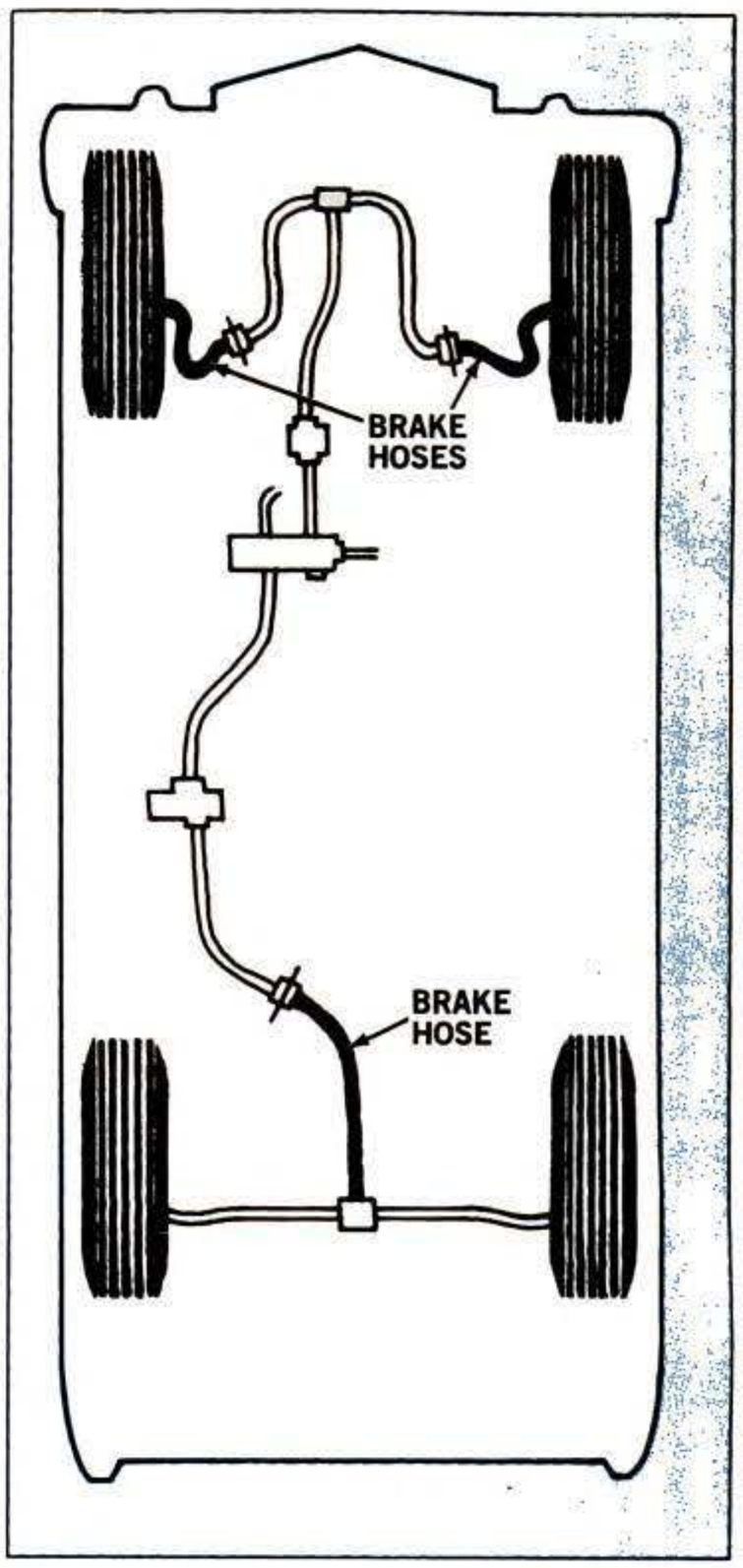
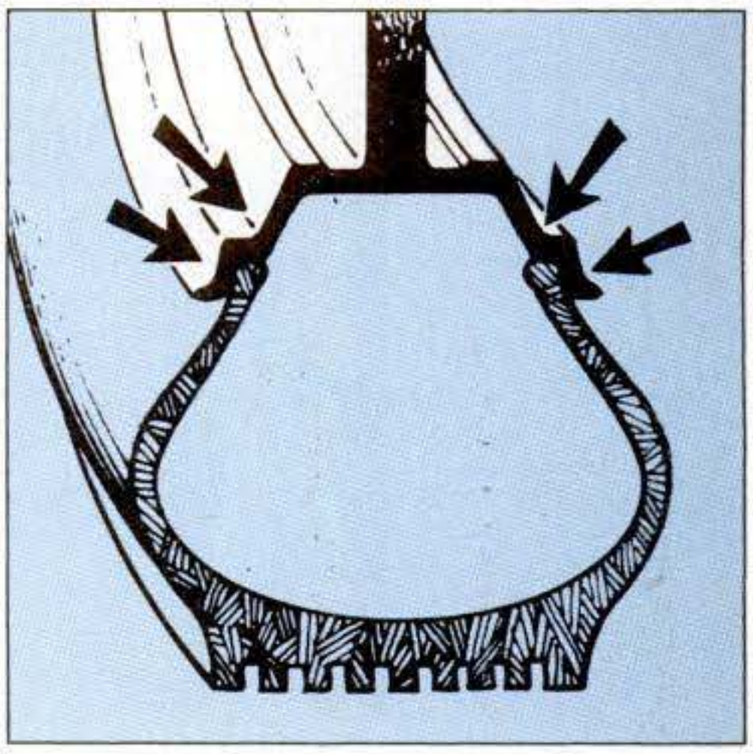


Rear brake-hose inspection

Most braking systems have several flexible hydraulic lines to link the rigid-steel brake lines with the moving calipers and drums. Because the rear lines may be tucked out of sight, they're often neglected during a brake inspection or when diagnosing a brake problem. Check them for cracks, leaks, or wear.



Wheels out of balance

Is your steering wheel vibrating as if your wheels are out of balance? Have you been driving through deep mud or snow? Before going to the expense of a dynamic balance, check both sides of the front-wheel rims for accumulations of mud or compacted snow. Just a few ounces on the edge of the rim can cause an unbalanced condition. Clean the rim with a stiff brush to restore the former smooth ride.

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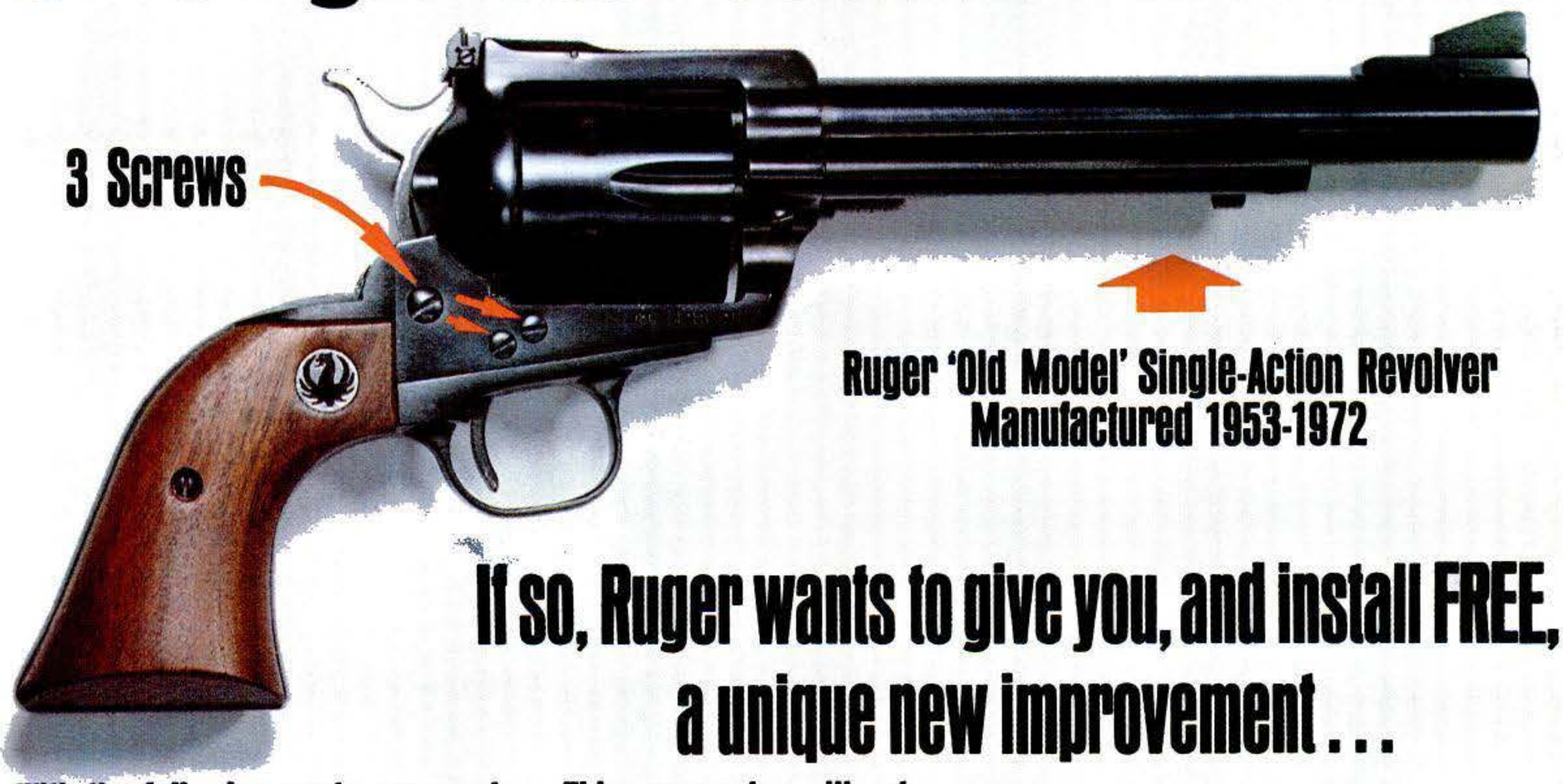

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Manufactured 1953-1972

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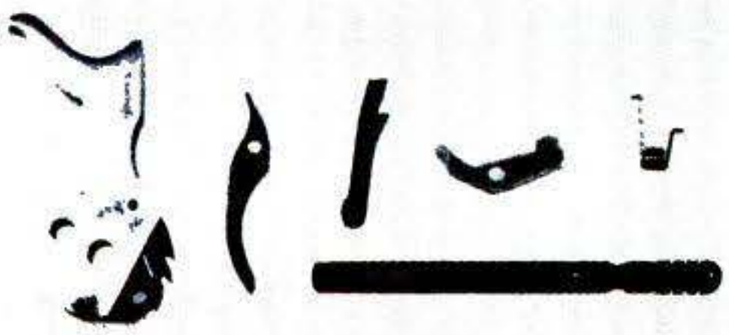

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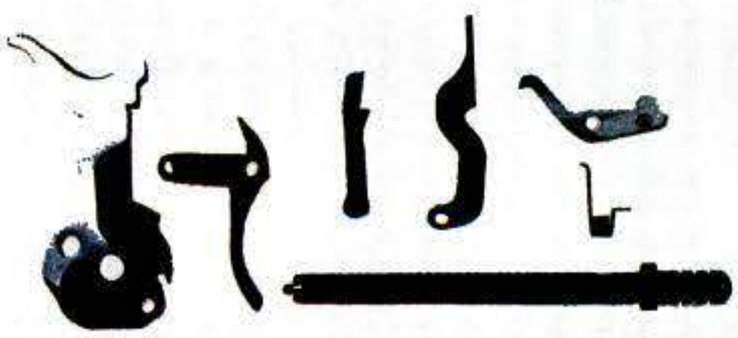

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This offer may be withdrawn at our discretion by December, 1983

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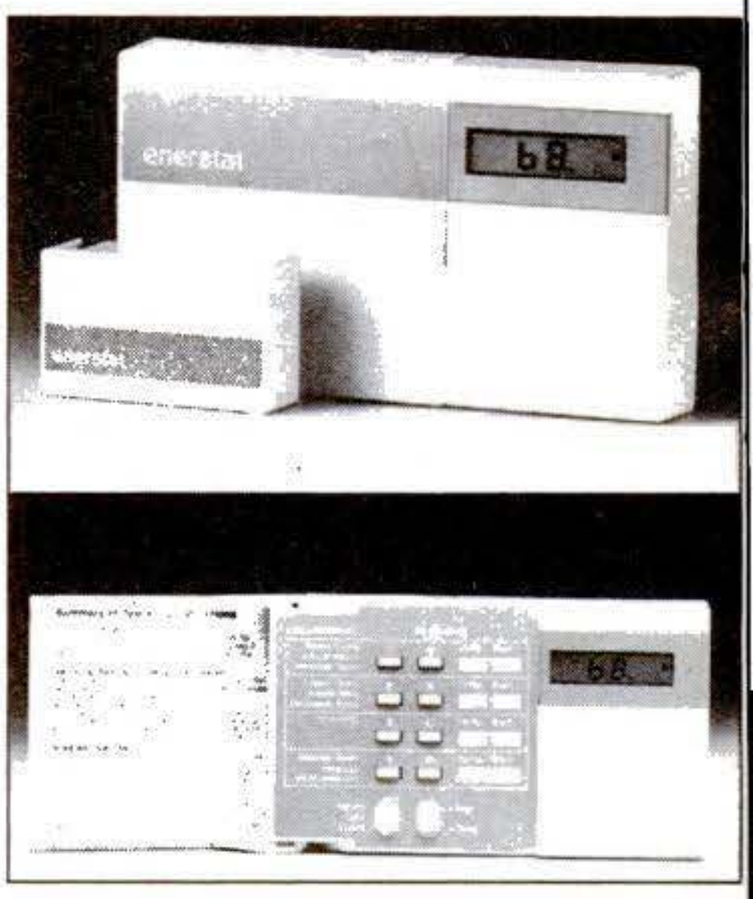
Smart thermostat
—easy to install, easy to use



Enerstat is shown in the top photo with its optional remote temperature sensor, a device that's handy when most convenient location for stat isn't the best spot to sense temperature. Cover plate opens to reveal eight buttons that program time and temperature settings (lower photo).

"Before you disconnect them, mark the wires coming to your present thermostat with the labels that come with Enerstat," Jerry Kathnelson told me. "Then disconnect the old one, hook up Enerstat, and program it."

I couldn't believe that installing a sophisticated electronic thermostat could be that easy. But Kathnelson was right. In less than 20 minutes I had mounted Enerstat on the wall and had put the gas furnace in our home on four daily temperature settings: 68 degrees F at 6:30 a.m., 64 degrees at 10:00 a.m., 68 degrees at 5:00 p.m., and 62 degrees at 11:30 p.m. When you're not entering setback times and temperatures, Enerstat's display alternates time of day and room temperature.

Of course, electronic thermostats aren't new [PS, Oct. '79]. But Enerstat, developed by engineers at Canada's National Research Council Labs, is the easiest to install and program I've seen. It has a remote temperature sensor (see photo), and controls central air conditioners and gas, oil, and electric furnaces.

Enerstat costs $130; Valera Electronics (1733 St. Laurent Blvd., Ottawa, Canada K1G 3V4) makes it.—*R. L. Stepler*

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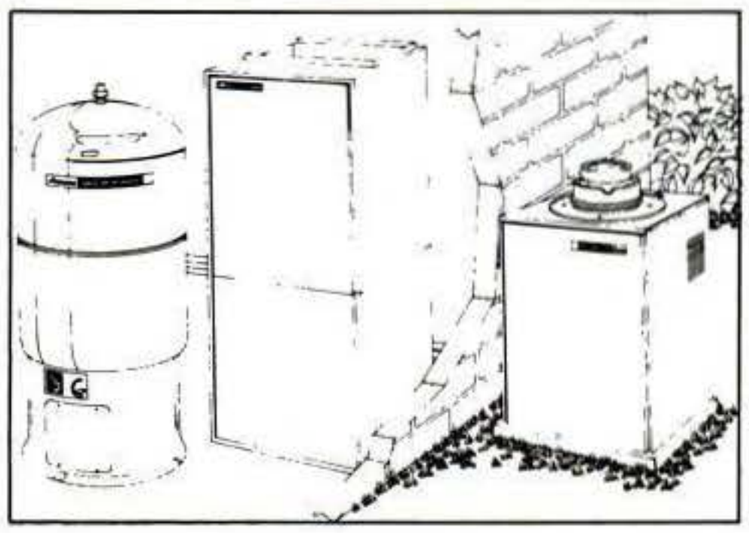
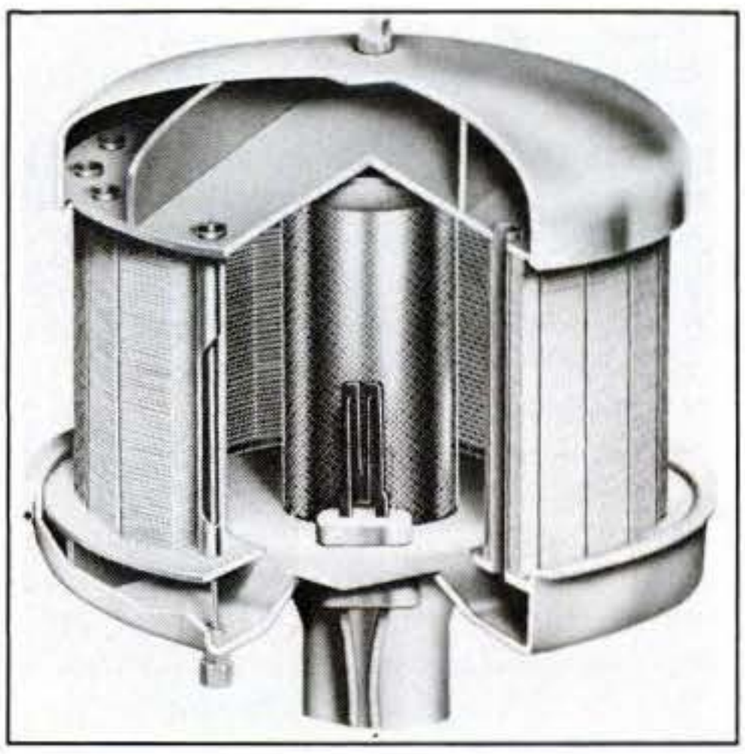


The smallest of the three boxes above houses an outdoor furnace with its own weatherproof flue. Natural gas or propane burned inside a compact combustion chamber turns into superheated gas that quickly warms a propylene glycol solution in the furnace's heat exchanger.

Though the burner itself is not new [PS, Nov. '79], Amana claims a first in coupling it remotely to a system that can heat or cool your house and make hot water, too.

When the house thermostat calls for heat, the Heat 'N Hot Water System sends hot liquid to the blower-coil unit indoors (tall cabinet in center) where it warms a stream of air. When hot water's needed, a diverter valve switches the hot solution to a heat exchanger in the 40-gal. water tank at left. You can add central air conditioning of 24-, 30-, or 36,000-Btu/h.

Said to be over 80 percent efficient, Amana's HTM Plus system can be set to burn at 80-, 100-, or 120,000 Btu/h. Installed cost is reportedly about 1½ times that of an ordinary gas furnace alone.—*Erik Arctander*



Heat-transfer module in furnace has a burner in center surrounded by tubes.

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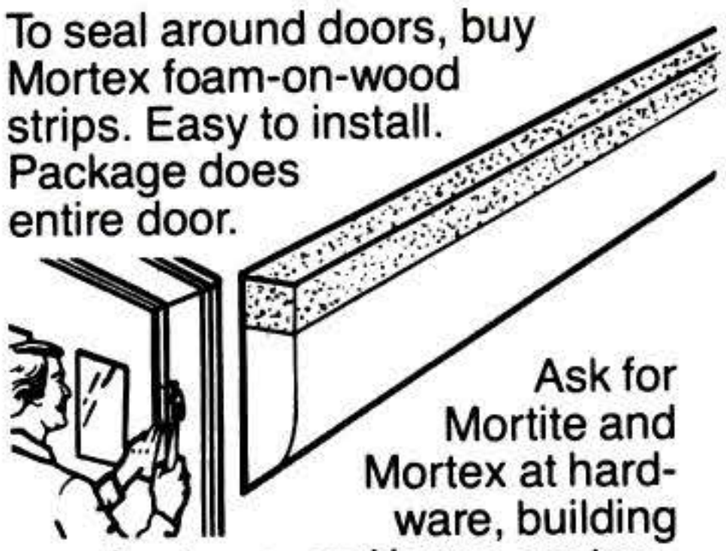

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HOUSEPOWER CLINIC

By EVAN POWELL

Energy-saving dispenser

An electric hot-water dispenser consists of a small heating tank that holds around ½ gallon of water, a special faucet, connecting tubing, and a plug that goes into an electrical outlet. Attaching it to the water supply usually requires only a simple self-piercing saddle valve.

A dispenser can be an effective means of reducing a portion of your water-heating costs, according to my own findings and a 1979 study conducted by Iowa State University (and sponsored by the In-Sink-Erator Division of Emerson Electric Co., Racine, Wis., a major manufacturer of dispensers).

The study found that with an average daily use of 10 eight-ounce cups, a dispenser costs about 4.38 cents a day to operate (after I extrapolated their figures to a realistic rate of six cents per kilowatt hour), or $1.31 per month. The same amount of water heated electrically on a range costs 80 percent more. Here at Chestnut Mountain, I improved that even more by installing a switch (with a pilot light) in the circuit that powers my unit. After I turn it on, I have piping hot water at the tap in little more than five minutes.

Most of these units cost from $80 to $120. In-Sink-Erator has just introduced a new model, H-330, with a ⅓-gallon tank that is capable of producing 40 eight-ounce cups of hot water per hour. It should sell for under $60. While it may take several years for the unit to repay its cost, the convenience of having instant hot water for coffee, tea, or other hot drinks is more than worth it to me.

Q&A Range wiring

The wires on the baking element of my Sears electric range keep "burning off." I have replaced the wire so often that I can do it in my sleep, but it has happened so frequently that I am beginning to think the element is bad. Do you have any suggestions before I spend another $30 on it?

B. Walters, Manchester, N.H.

That $30 would probably do little to cure your problem unless the element terminals are badly deteriorated after repeated failures. Range-wiring connections are critical, and with holiday cooking loads coming up soon, it's a good time to check them.

First of all, the terminals where you make the connections must be as good as new. They must be clean and bright; this usually means replacing the terminal on the wire with a new high-temperature terminal (available from appliance-parts distributors and dealers) and cleaning the terminal on the component thoroughly. It's better to use a terminal with a screw connection rather than a crimp type, looping the wire around the screw in the same direction the screw turns. If you must use a crimp-type terminal, use the proper tool for crimping and solder the connection, as well. If the wire has burned off, strip the insulation back to a point where the wire is bright and shiny. A dull appearance or the presence of oxide means the wire has overheated, and unless you remove all of this portion a second failure is certain. I suspect that this may be the cause of your repeated problems.

If you must splice a wire in a range, use only high-temperature wire nuts. Because of the high temperatures, electrical tape should not be used.

Bypassing range timer

I own a Caloric range and would like to know how to disconnect the clock and timer without affecting the oven or broiler operations.

Paul Fruge, Metairie, La.

I assume that the switch section on your range timer has failed, preventing the oven from operating, and you want to avoid the expense of a new timer.

To bypass the timer switches, remove power from the range circuit (by pulling the fuse or shutting off the circuit breaker in your home's main electrical panel), then unplug the range and remove the access panel that covers the back of the timer. You'll see that one wire comes from the power supply of your range to a terminal on the timer switch, usually marked L1. Another goes to the thermostat or oven switch, and is typically labeled T1. Just place both these wires under the same screw terminal and you will have by-

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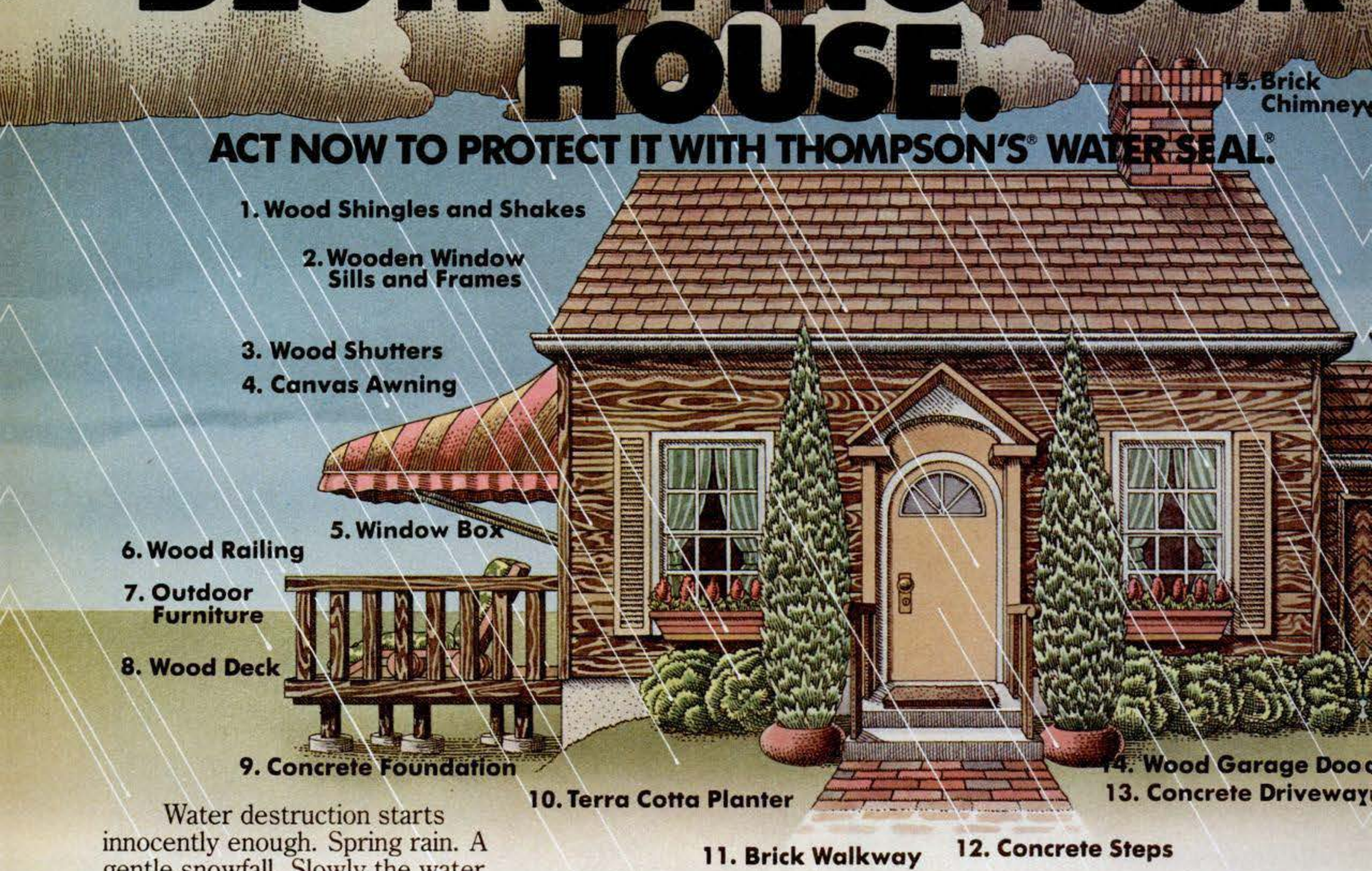

Water destruction starts innocently enough. Spring rain. A gentle snowfall. Slowly the water creeps...drip...drip. And seeps...drip...drip. Penetrating into tiny airpockets and crevices. Until shingles warp. Concrete walls crack and chip. Even the very foundation of your home can begin to crumble.

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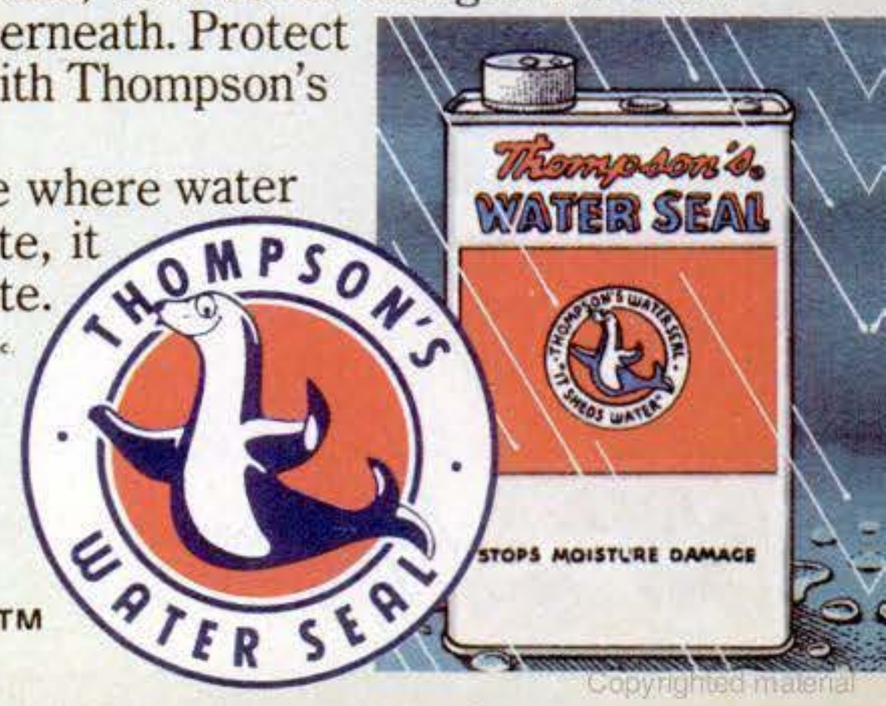

THOMPSON'S WATER SEAL™

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Housepower clinic

[*Continued*]

passed the timer switch. The clock will continue to operate as before, but the switching functions will be inoperative.

One word of warning: Some electric ranges have two timer switches, and some have two "line" wires attached. Never connect the two line wires together. *Finally, reinstall the cover and plug the range back in before turning the power on.*

Wise reader

I believe that some people are taking advantage of this country's critical energy situation. I recently received a brochure from a firm offering to "custom-fit your water heater with one of our thermal jackets." I am a steam fitter, and this statement didn't sound right to me because my water heater is well insulated. To be sure, I ran a test on my own system. Using two dial thermometers, both calibrated exactly the same, I checked the temperature of the water-heater jacket and the air away from it in the same general area. There was no evidence of heat loss from the heater and therefore no need for a thermal jacket.

James Massick, Seattle, Wash.

Actually, thermal-insulation jackets can be quite beneficial for some water heaters, especially older ones with substandard insulation. But no energy-saving device is cost-effective if there is no need for it. You were wise to check your own heater before installing one.

Clogged refrigerator drain

My five-year-old General Electric refrigerator has a problem with the drain line that carries the water from the refrigerator compartment: It becomes blocked frequently—this summer I had to clean it out about once a week. Is there any way to stop this problem? The fridge runs beautifully otherwise.

James Truman, Orlando, Fla.

There are two reasons why refrigerator drains clog: algae or ice buildup. The secret to curing an algae problem, a common trouble in humid climates, is to be sure that all of the blockage is cleared away. You may have to remove the line to do this. GE suggests using a meat baster with a slender tapered tip to force air or hot tap water through the drain tube. The best preventive is to pour a solution of one teaspoon of baking soda and two cups of hot (not boiling) water into the drain opening once or twice a year.

If yours is a model with the TFF prefix and you find icing to be the cause, GE makes a drain-tube heater kit (part No. WR49X248) to correct the condition. It consists of an aluminum drain tube, low-wattage heater, and instructions.

Got a home-equipment problem? Write to Evan Powell/Housepower, Chestnut Mountain, Route 1, Box 322A, Travelers Rest, S.C. 29690, giving appliance make and model number. Unpublished questions cannot be answered by mail.

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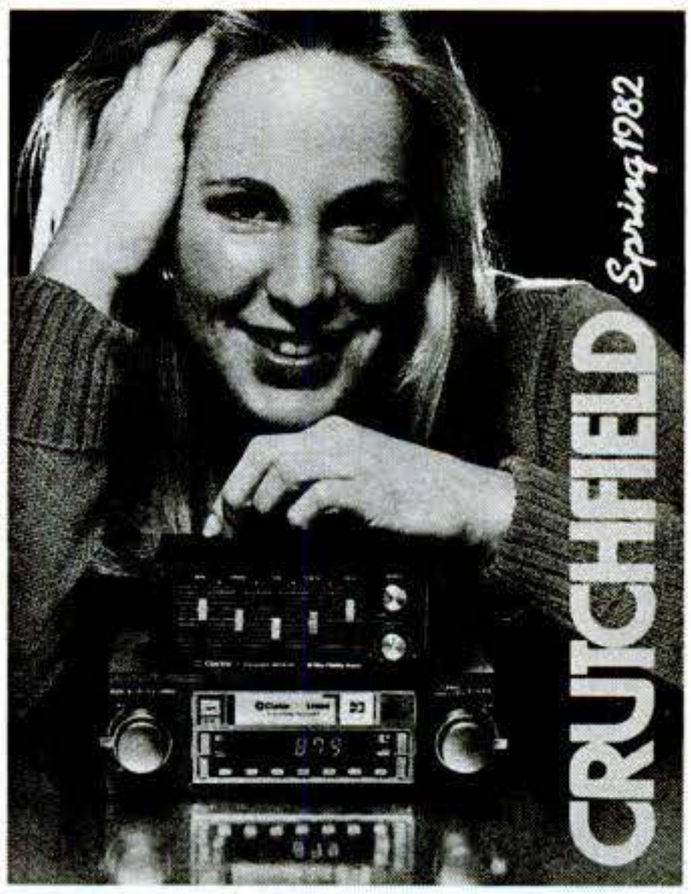

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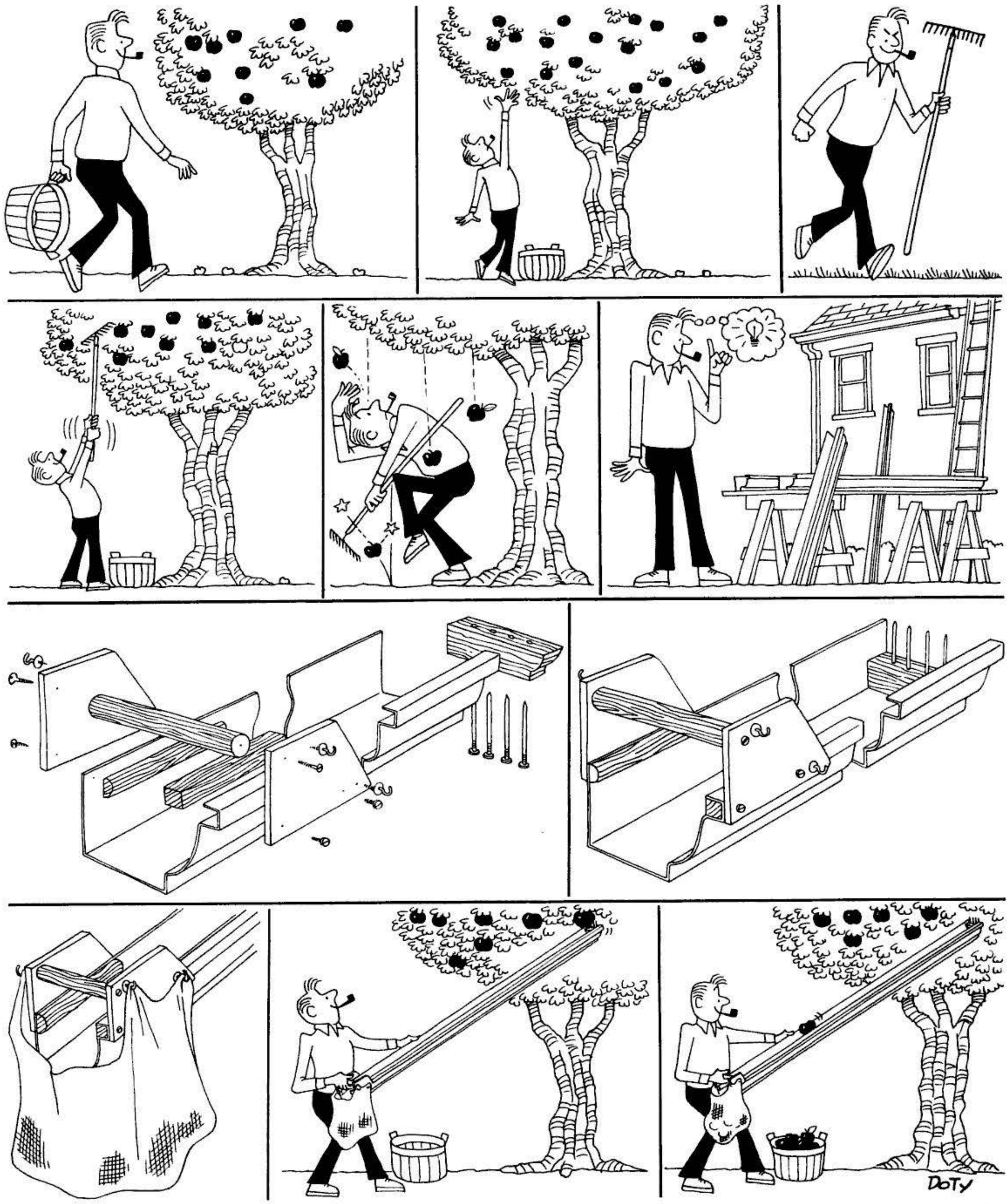

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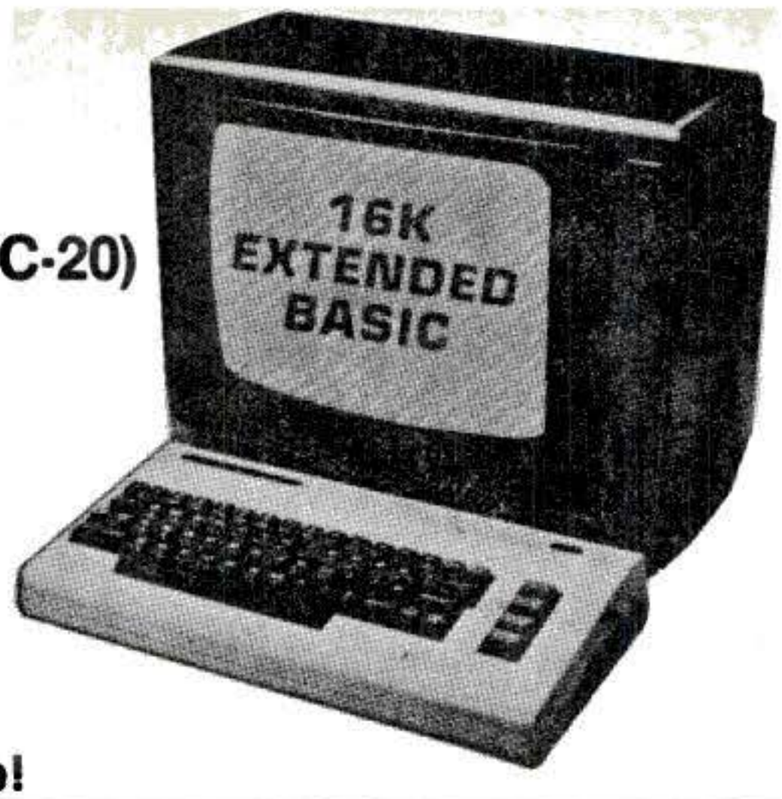

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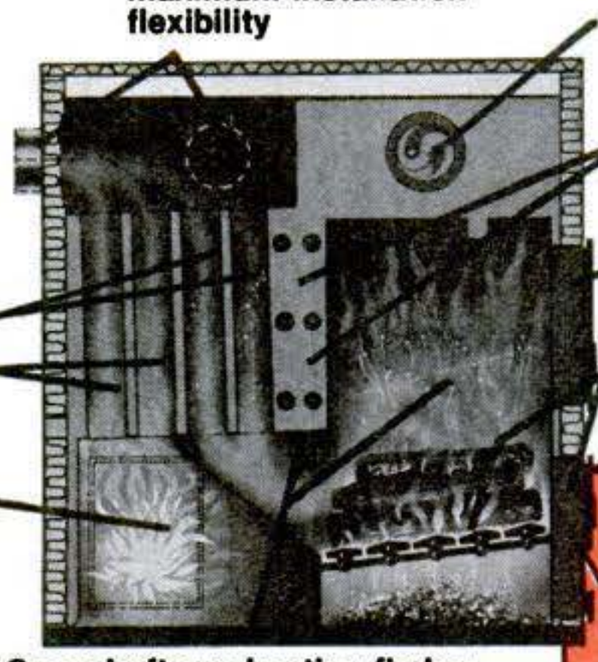

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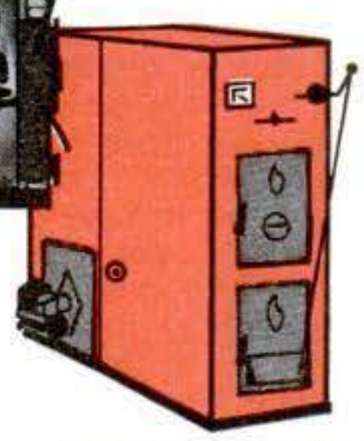

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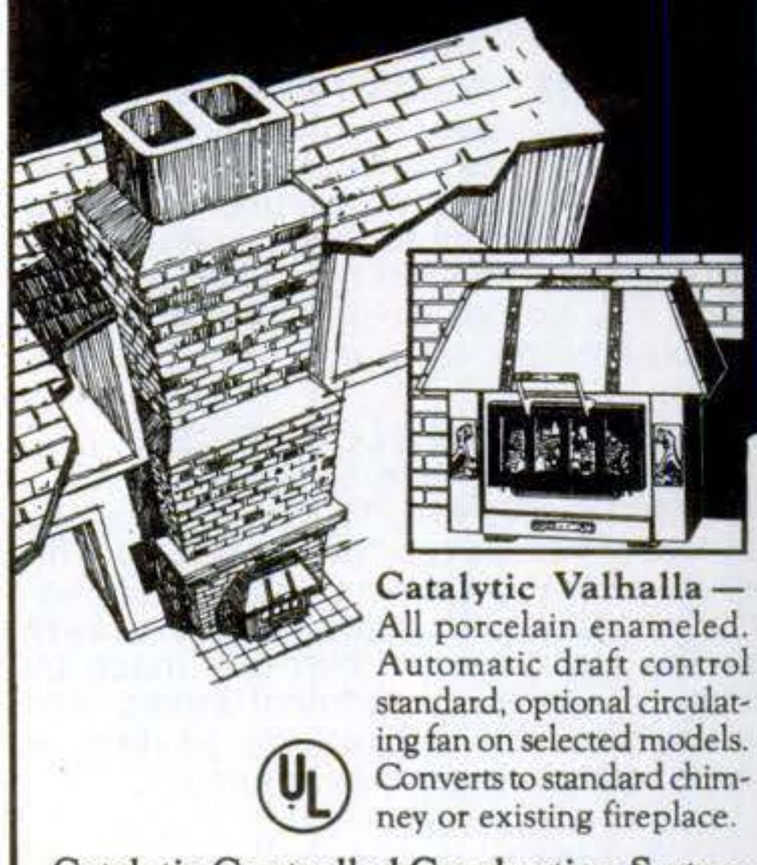

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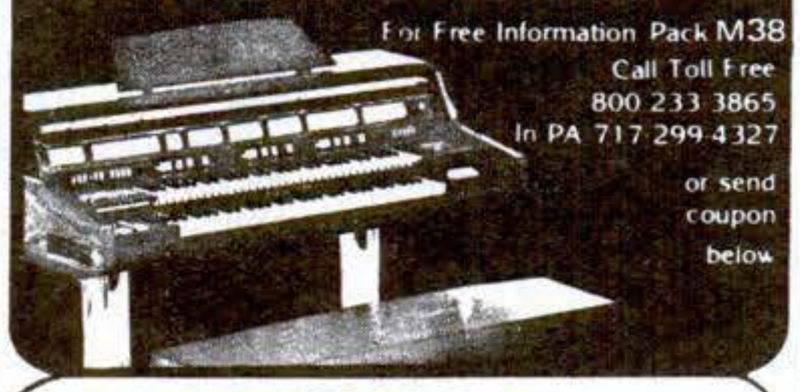

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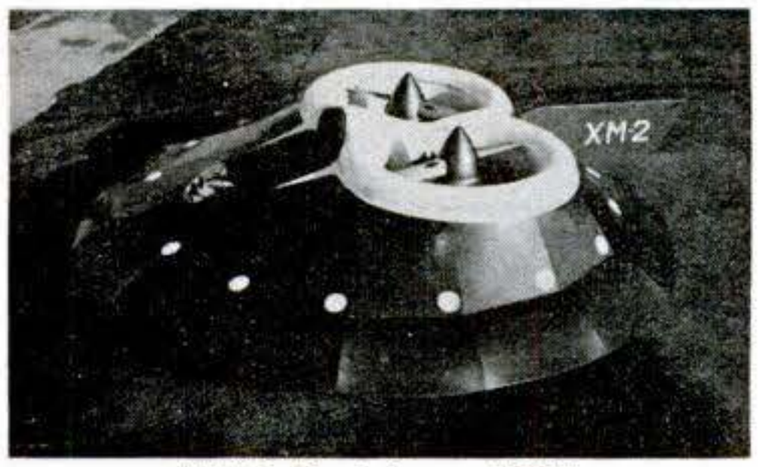

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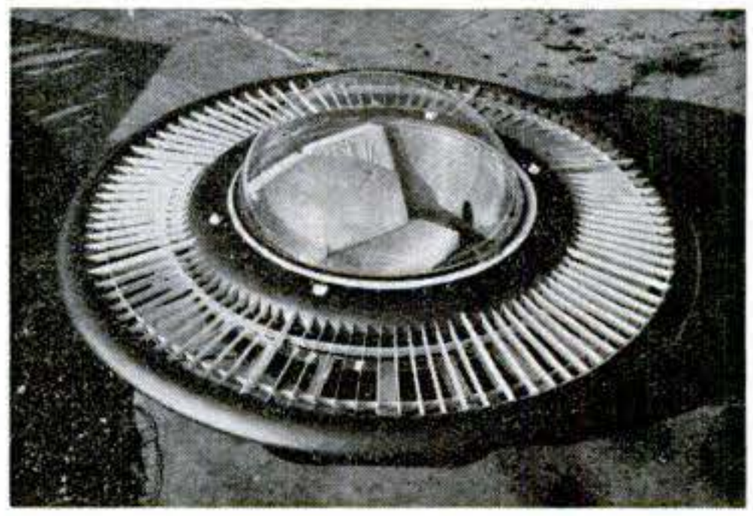

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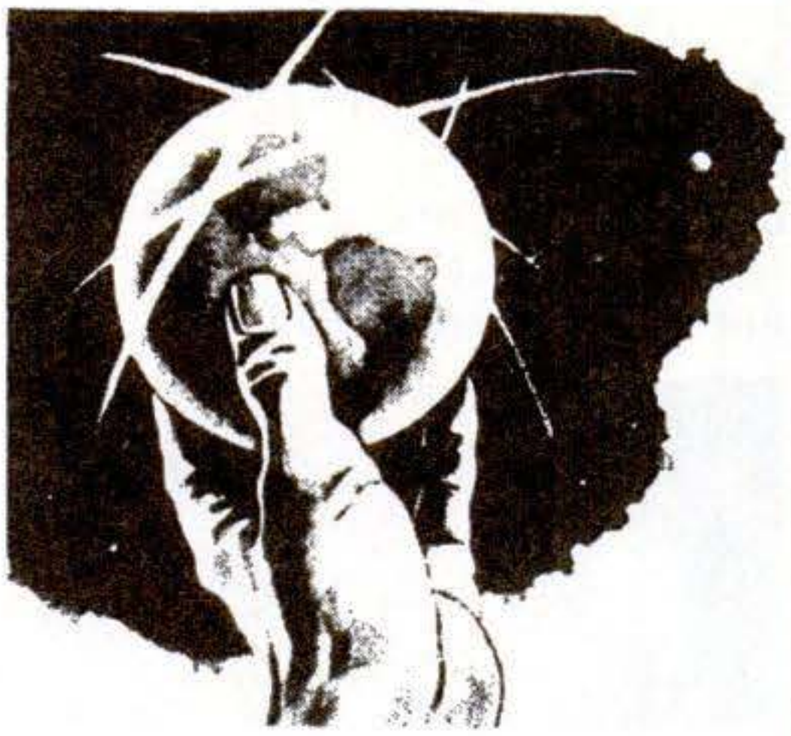

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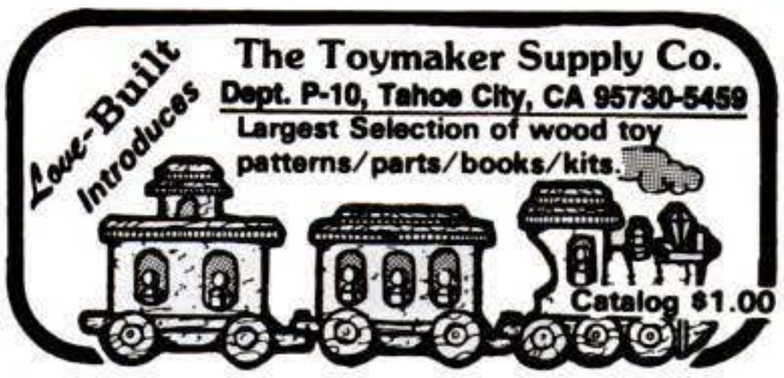

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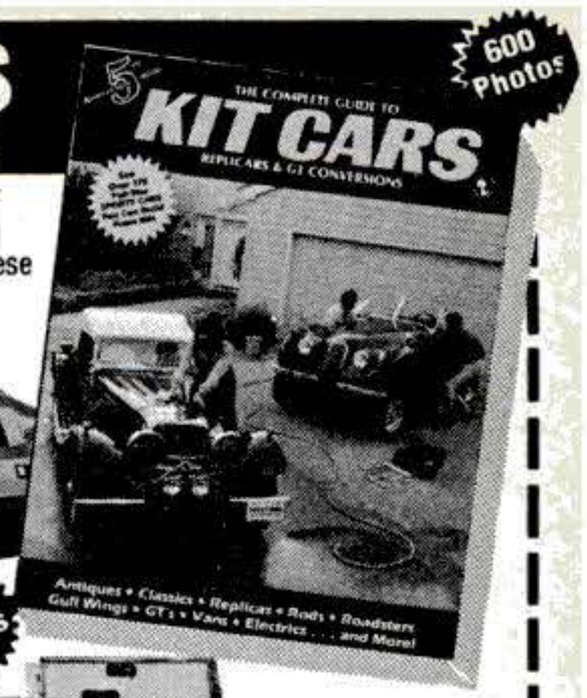

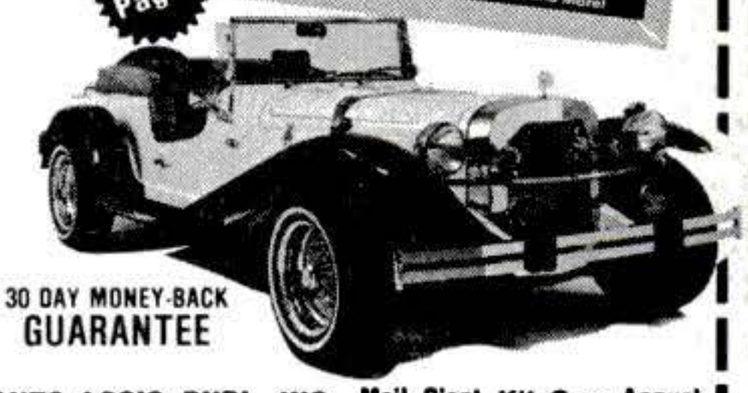

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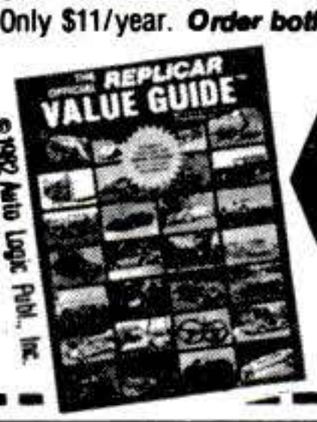

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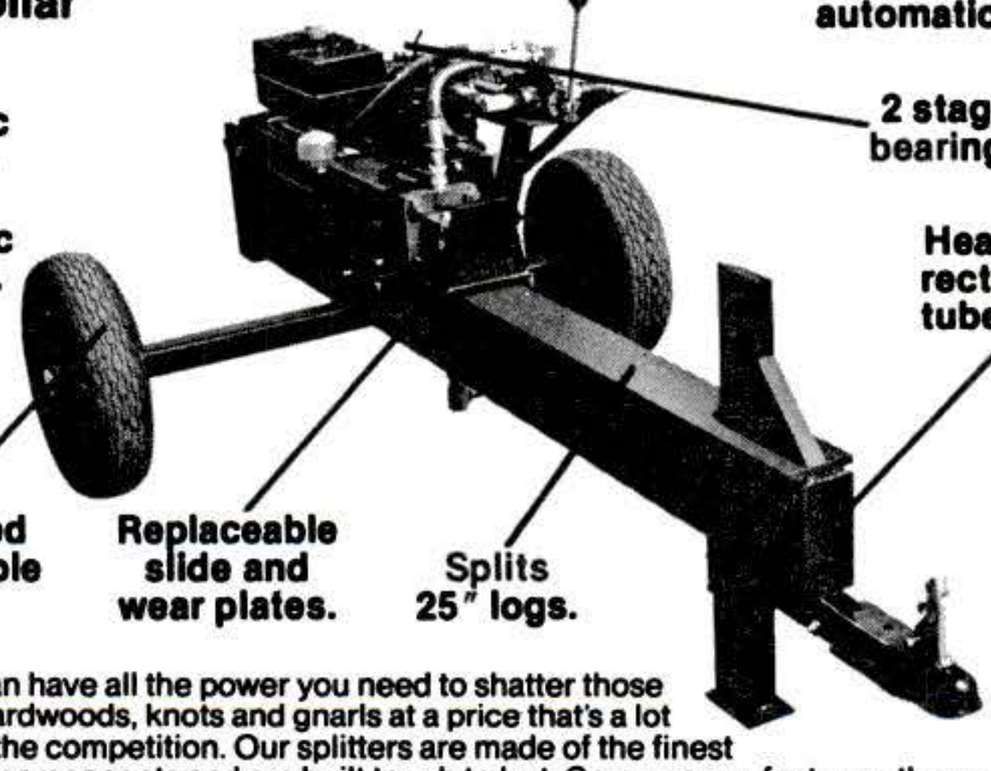

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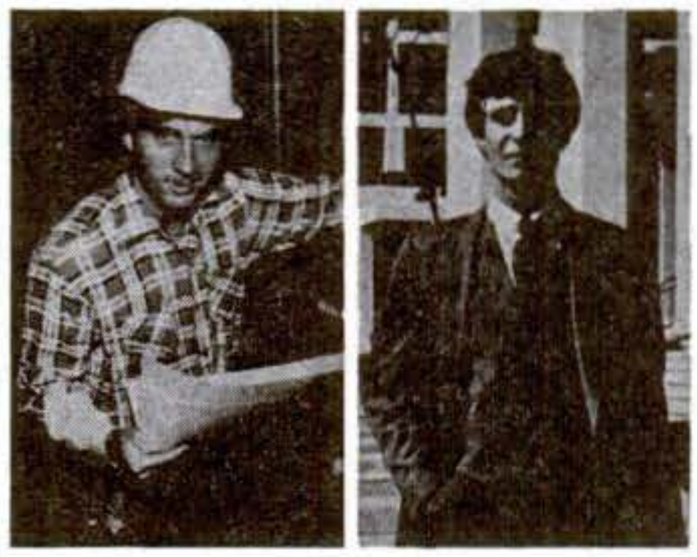

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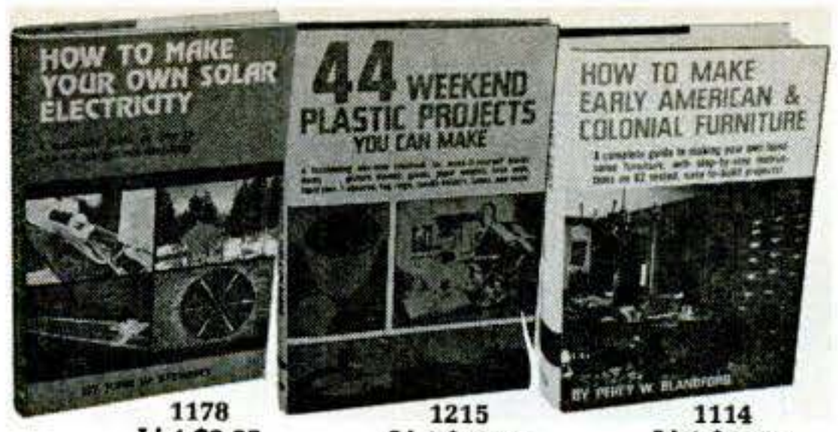

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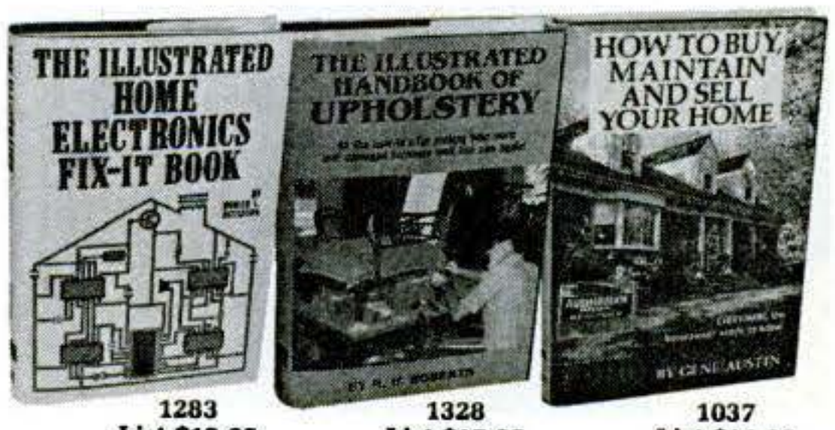

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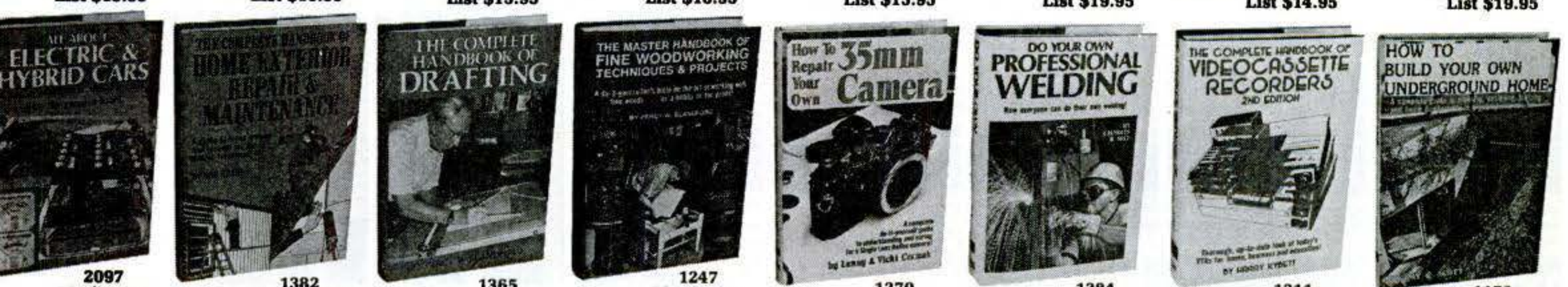

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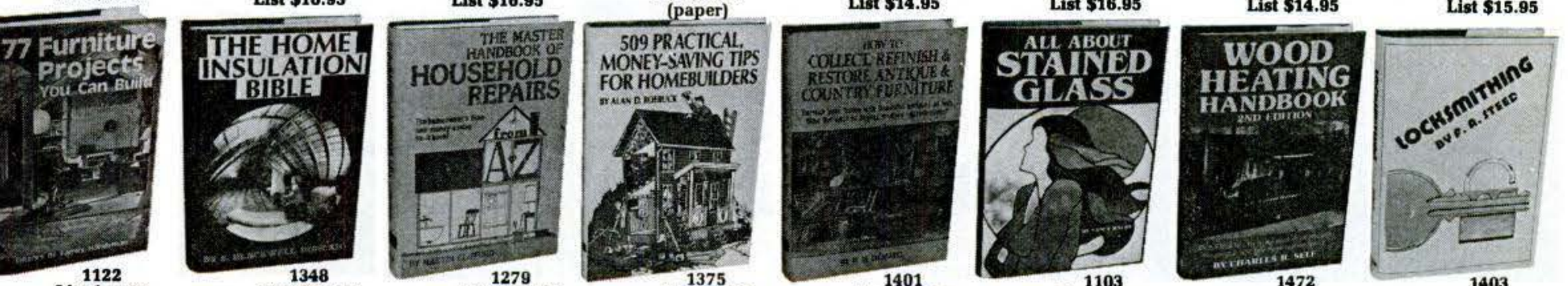

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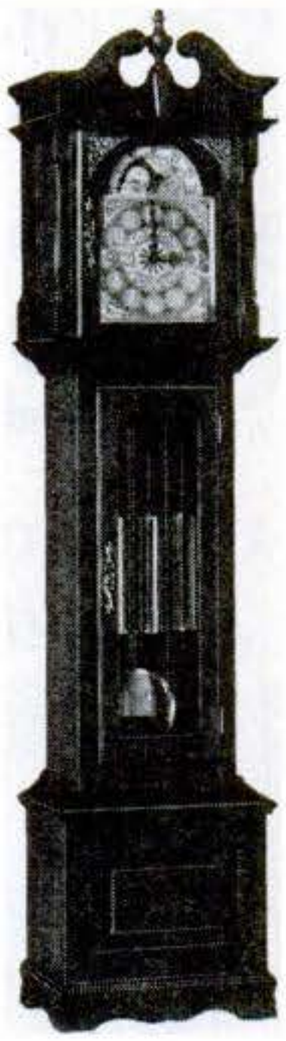

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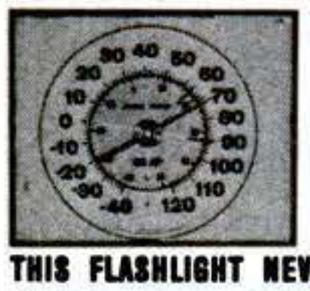

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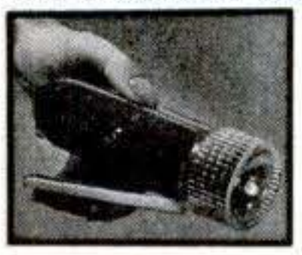

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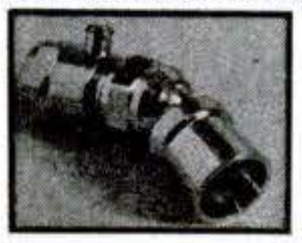

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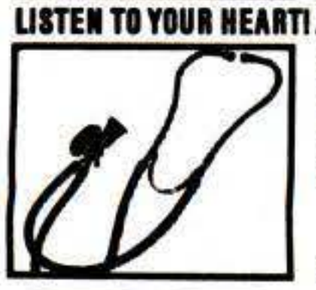

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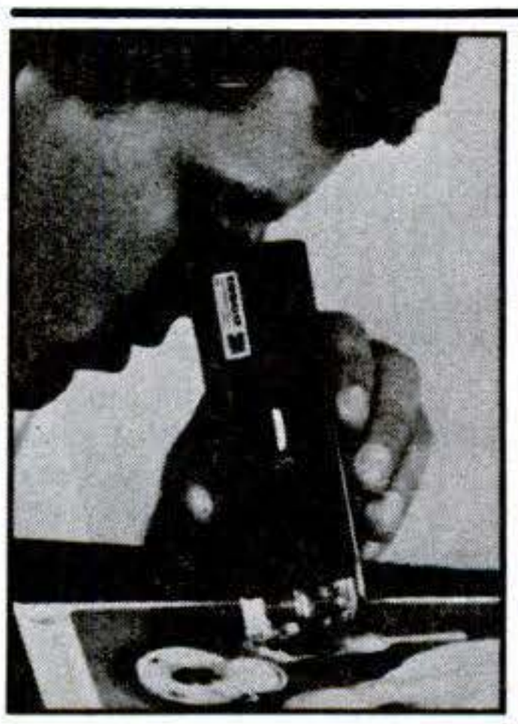

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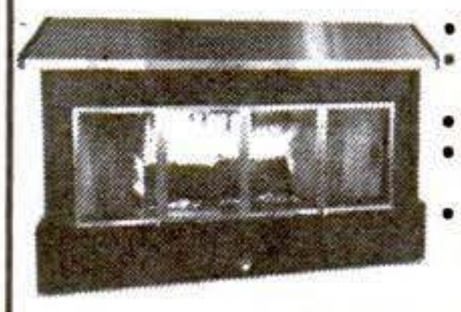

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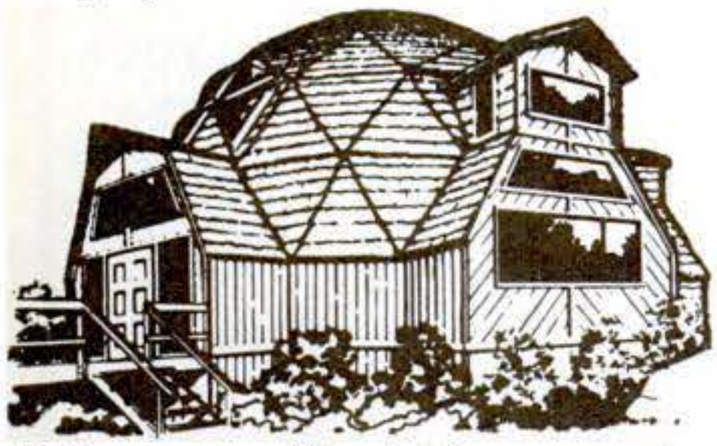

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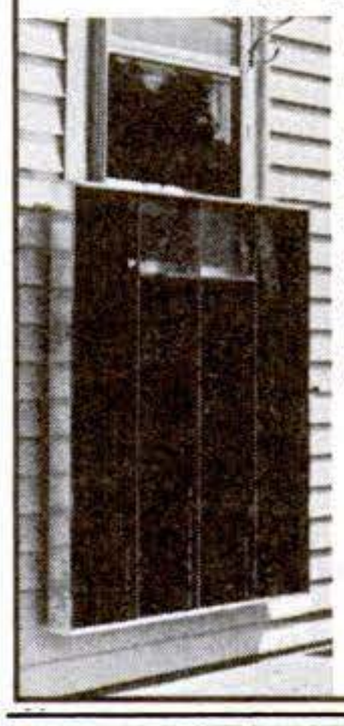

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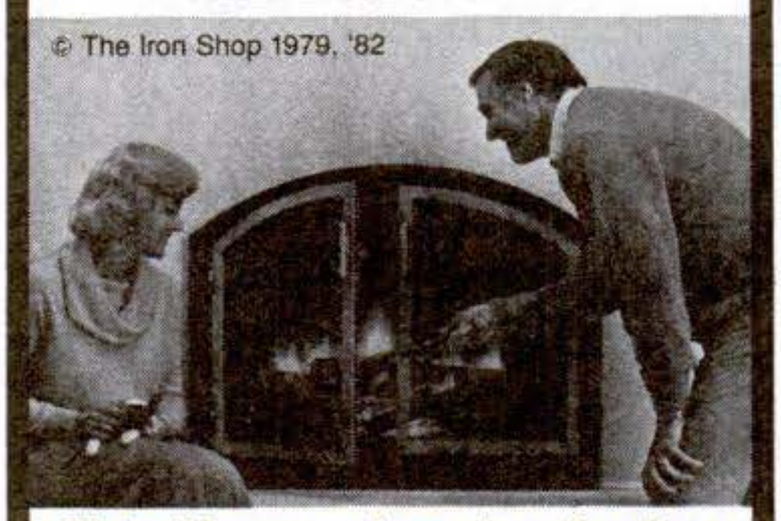

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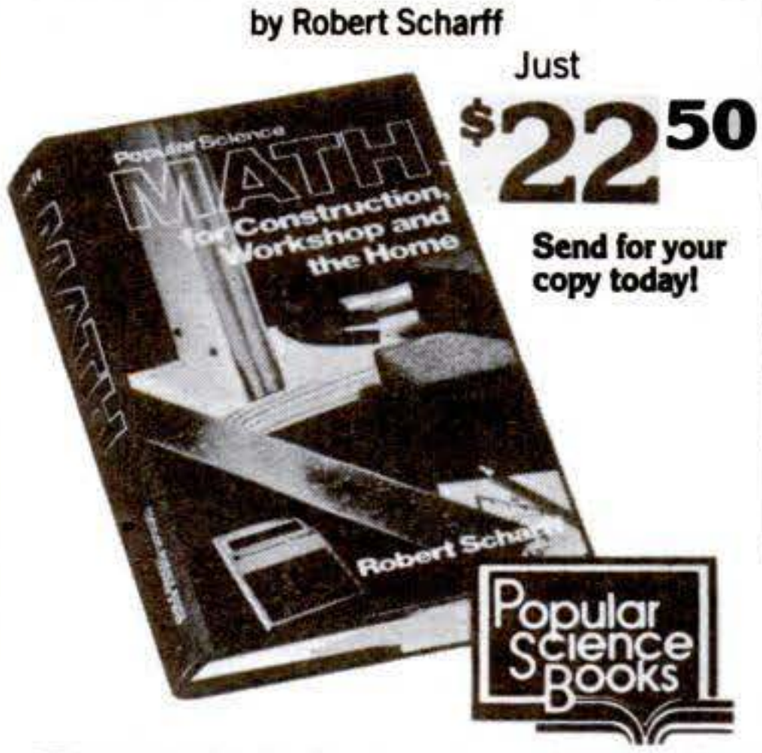

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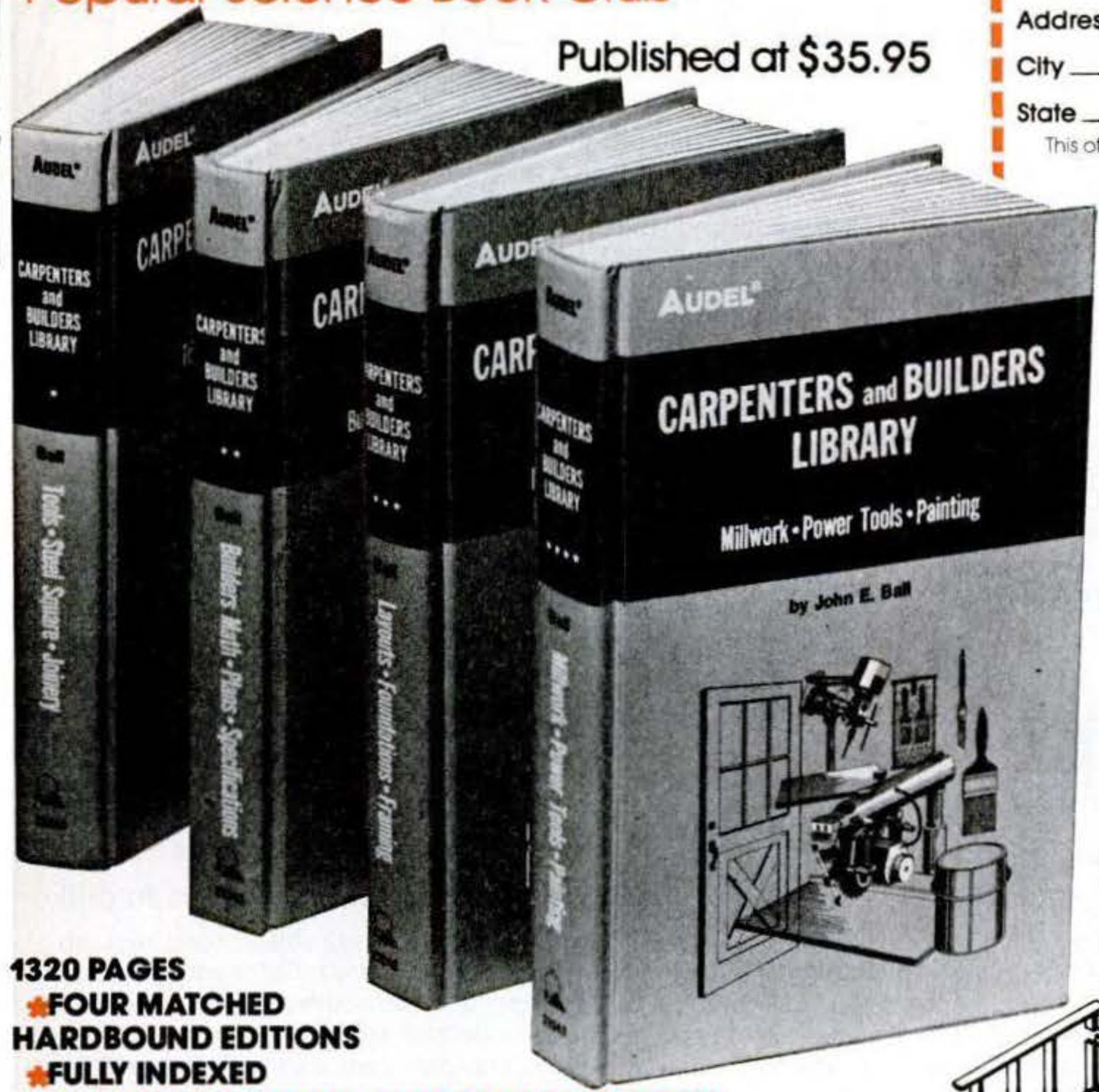

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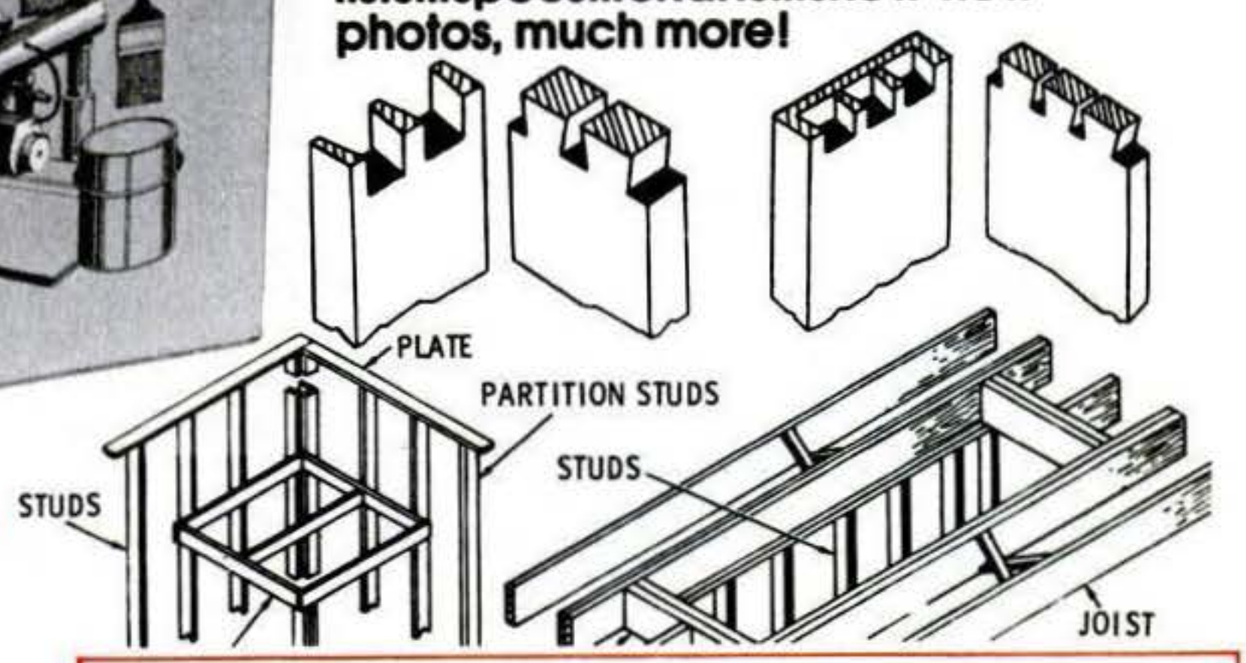

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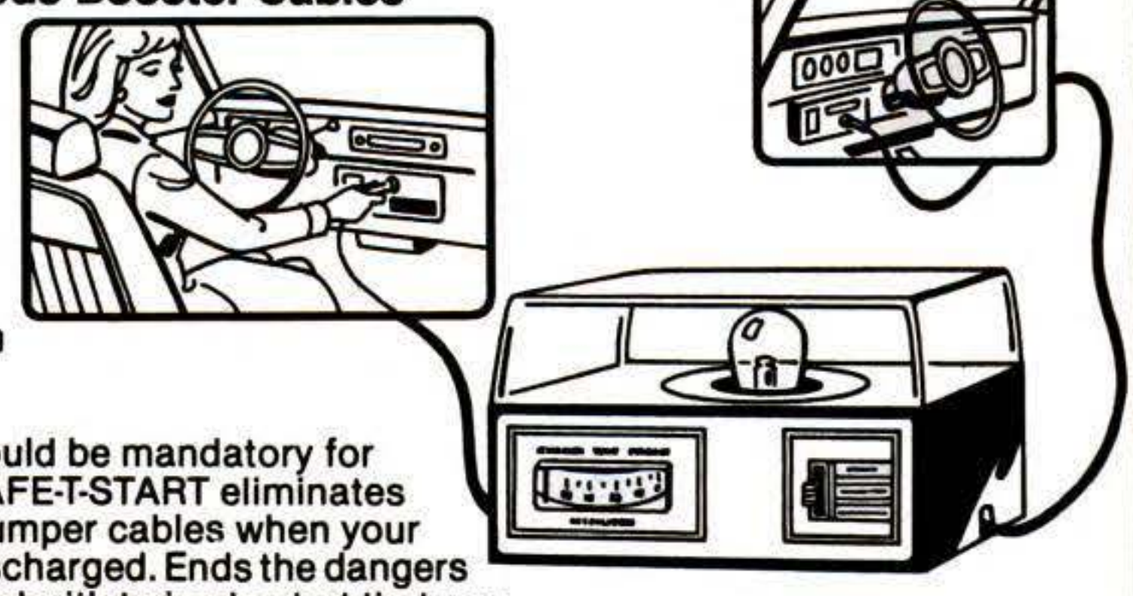

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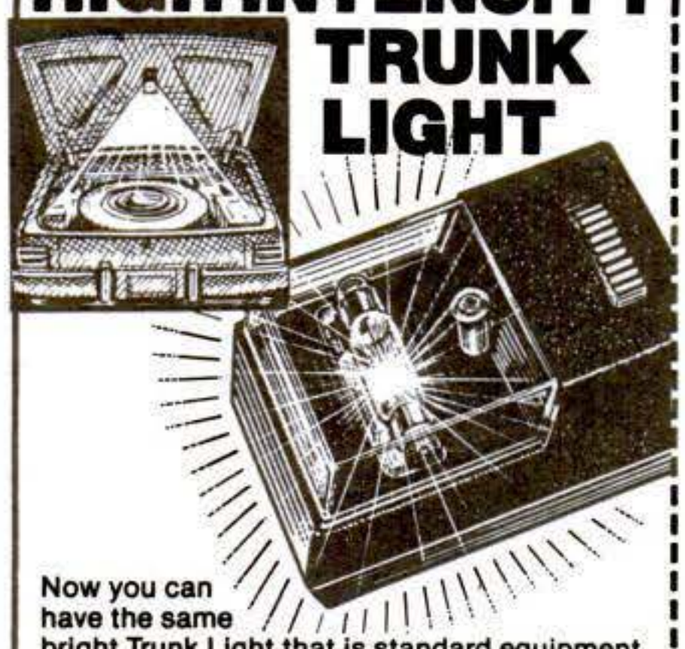

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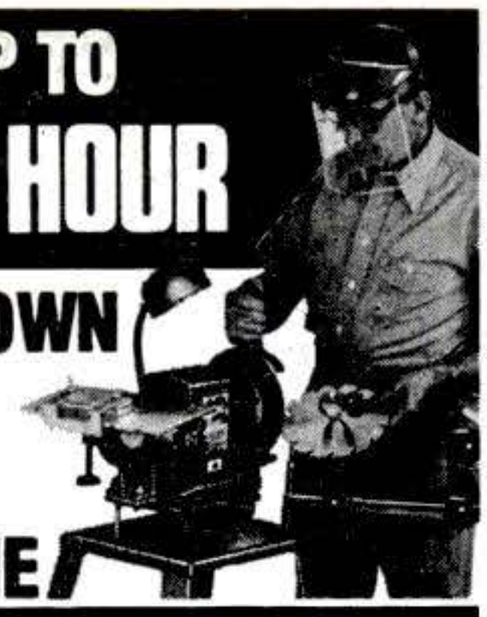

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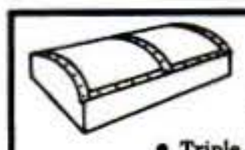

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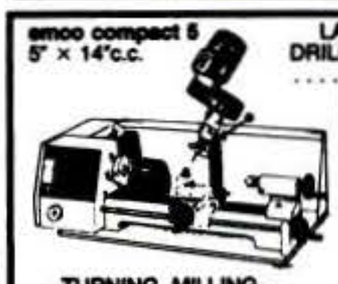

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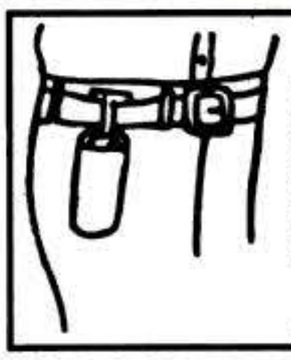

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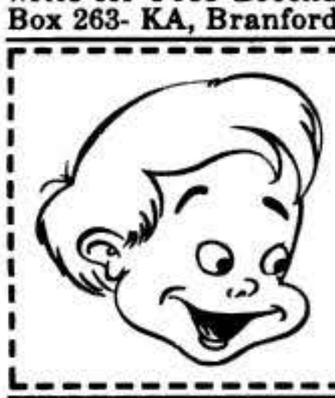

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1015 Lower-Back Pain Are you suffering needlessly? A new report from Lumbar Institute Research Div. shows how thousands have obtained relief. $1

1016 Tips on Wood Finishing This 22-page booklet from Minwax includes numerous tips that save time and trouble for do-it-yourselfers. Everything from applying a preservative stain on a house to restoring the finish on a priceless antique is explained. Free

1017 Wood-Burning Fireplaces The full-color performance report and do-it-yourself planner brochures feature Majestic's most efficient fireplace, the Warm Majic. It's available with outside-air-intake and glass-enclosure kits. Brochures include color photos and illustrations of the fireplace and chimney installations. $1

1018 Fiberglass Shingles Booklet from Manville Building Materials Corp. points out advantages of fiberglass shingles. J-M fiberglass shingles have earned a UL Class-A fire-resistance rating and are backed by a 20- to 25-year limited, prorated warranties. Free

1019 Travel Guide This brochure from Mobil rates 20,000 hotels, motels, resorts, and restaurants. It includes room rates, menus, credit cards accepted, road maps, things to see and do, and more. $6.95

1020 Make an Old Window as Good as New This 12-page leaflet from Marvin Windows shows how its wood replacement-sash system upgrades old, inefficient double-hungs. They're available in over 90 standard sizes or can be made to order. Free

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1024 Advice for Chain-Saw Owners This 16-page guide to the care and maintenance of chain saws contains invaluable information on chain care, lubrication, tensioning, types of saw chain, filing, guide-bar and sprocket care, and troubleshooting. From Stihl. 50¢

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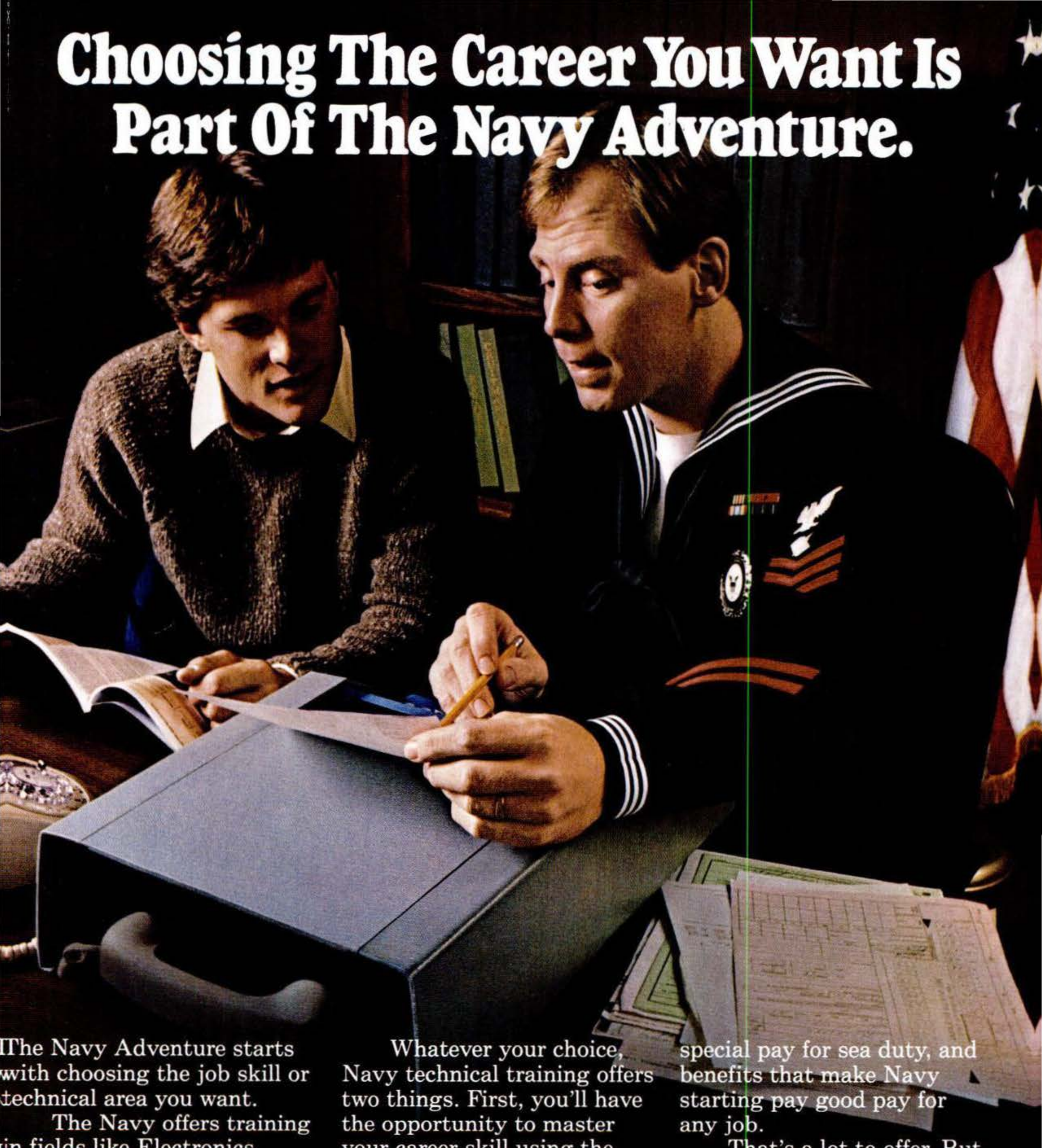

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